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The focus of this conference was analyzing the impact of curricular innovations upon science teacher education. Included are a number of papers presented at the conference. The science and mathematics inservice programs in Kansas, particularly the Introductory Physical Science Program, are discussed. The Science In-Service Project at the University of Texas is explained, as well as the curriculum development within the Dallas Junior High Schools. Included is a report of the introduction of the Earth Science Curriculum Project into Arizona, Idaho, Nevada, New Mexico, and Utah with the aid of the Cooperative College-School Science Science Program. The use of inservice teacher education programs for introducing the major elementary school science projects in Colorado is discussed. Another paper describes problems of preservice teacher education resulting from new science programs. (RR)

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FOREWORD

The Southwest Regional Conference of the Association for the Education of Teachers in Science was held in Emporia, Kansas on February 14-15, 1969.

The program committee included Dr. Glenn Crumb, Dr. Jake Blankenship, and Dr. David Butts. Arrangements for meeting rooms and facilities were made by Dr. Crumb and Dr. Roger Pankratz. Dr. Harold Durst and Dr. Guy Homman took care of the registration and finances. Eugene Crawford and DeWayne Backhus were principally responsible for the hospitality. John Nickel, Mrs. Twyla Sherman, Herb Simmons, and Don Acheson coordinated the transportation arrangements. Dr. Gerald Abegg and Herb Simmons served as the publicity committee.

This booklet includes the papers presented at the Conference. The AETS Regional Meeting will be held next year at Oklahoma State University under the chairmanship of Dr. Jake Blankenship.

William S. LaShier, Jr.
Vice-President

WELCOME TO THE 1969 SOUTHWEST REGIONAL CONFERENCE OF AETS

The hosts for the 1969 AETS Regional Conference include faculty members from the Kansas State Teachers College and the staff of the Flint Hills Elementary Science Project. Three science education programs are currently underway which reflect the cooperative efforts of both the college and the surrounding school districts.

Flint Hills Elementary Science Project

The Flint Hills Elementary Science Project is funded under Title III of the Elementary and Secondary Education Act of 1965. The science project is one of three major programs developed by the Flint Hills Educational Research and Development Association. This Association was formed in 1965 by the school superintendents of eight rural unified school districts. Since then, the Association's membership has increased to thirteen school districts located in a 4,200 square mile area of east central Kansas.

The establishment of this exemplary consortium of school superintendents in these rural unified school districts was accomplished through the cooperation of the school superintendents and Dr. Laurence Boylan, Dean of Academic Affairs at Kansas State Teachers College; Dr. J. T. Sandefur, Associate Dean of Academic Affairs and Acting Chairman of the Division of Teacher Education at KSTC; and Dr. Glenn H. Crumb, Professor of Physical Science and Coordinator of the Office of Research and Grants at KSTC. The first director of the Flint Hills Elementary Science Program, Dr. Gerald L. Abegg, was quite instrumental in developing and implementing the plans for the science programs which are currently being implemented in the seven counties involved in the Flint Hills Project. Dr. Abegg was ably assisted by the present Coordinator of Science, Mr. Herbert N. Simmons.

The Flint Hills Elementary Science Project has provided 6th, 7th, and 8th grade teachers with institute workshops on various new science curriculum materials over a period of three years. Other teachers in the Flint Hills Association have received help through in-service workshops and consultant services provided by the project.

NSF - CCSS Institute in Earth and Physical Science

Earth Science and Physical Science teachers from the Flint Hills Association and the Topeka, Kansas Public Schools are participating in a program designed to improve science instruction by familiarizing teachers with Earth Science Curriculum Project (ESCP) and Introductory Physical Science (IPS) materials.

NSF - CCSS Institute for First and Second Grade Teachers

The present director of the Flint Hills Elementary Science Project, Dr. William S. LaShier, Jr., and Dr. Edwin B. Kurtz, Chairman of the Biology Department at KSTC, will direct a NSF Cooperative College-School Science Project during 1969-70. The purpose of the project is to introduce the rationale and use of the AAAS materials during the 1969 summer and to implement these materials in the classrooms of 35 first and second grade teachers and principals in the Flint Hills Association.

AETS PROGRAM

Friday - February 14, 1969

Ramada Room - 1:00 P.M.

Presiding:	Dr. William S. LaShier, Jr. Vice-President, AETS Southwest Region
Welcome:	Dr. John E. Visser, President Kansas State Teachers College, Emporia, Kansas

Session A - 1:15 P.M.

Science Education Innovation in Local School Districts

Mrs. Twyla Sherman, presiding
Wichita State University, Wichita, Kansas

Dr. Ronald D. Anderson
University of Colorado, Boulder, Colorado
"Introducing SCIS, AAAS, and ESS Materials in Colorado Schools"

Respondent: Dr. Leo Mahoney
University of Houston, Houston, Texas

Dr. Paul Cowan
North Texas State University, Denton, Texas
"Dallas, Texas Junior School Project - A Curriculum Development Project"

Respondent: Dr. Andrew Stevenson
Kansas State Teachers College, Emporia, Kansas

Coffee Break

Session B - 3:00 P.M.

Regional Science Curriculum Implementation

Dr. Jacob W. Blankenship, presiding
Oklahoma State University, Stillwater, Oklahoma

Dr. Glenn H. Crumb
Kansas State Teachers College, Emporia, Kansas
"Science and Mathematics In-Service Training in Kansas"

Respondent: Professor Don E. Acheson
University of Missouri, Kansas City, Missouri

Dr. David P. Butts
The University of Texas, Austin, Texas
"Manpower Development in Texas"

Respondent: Professor John Nickel
Wichita State University, Wichita, Kansas

Southwest Regional Buffet - 7:00 P.M.

Speaker: Dr. Paul Westmeyer, Chairman
Science Education Department
Florida State University
Tallahassee, Florida

Social Hour, Ramada Inn - 9:30 P.M.

Courtesy of: Mr. Bob Zuvanich, McGraw-Hill & Mr. Charles Peterson, Xerox

Executive Committee Meeting - 10:00 P.M.

Saturday - February 15, 1969

Session C - 9:00 A.M.
Campus of Kansas State Teachers College, Room 72 of the Science Hall

Interregional Science Education Programs

Mr. James Metzdorf, presiding
State Science Consultant, Denver, Colorado

Dr. Edward Stoever
Associate Director of ESCP, Boulder, Colorado
(On leave from Oklahoma University)
"Introducing ESCP in Five Western States"

Dr. Gerald L. Abegg
Coordinator, IPS Program
Kansas State Teachers College, Emporia, Kansas
"The IPS Teacher Education Program"

Dr. Claude Gatewood
Educational Research Council of America, Cleveland, Ohio
"The Impact of Science Education Research in Bringing About Change"

Dr. Edward Kurtz
Chairman, Biology Department
Kansas State Teachers College, Emporia, Kansas
"The Conference in Retrospect"

Business Meeting - 11:00 A.M.

FOSTERING CURRICULAR CHANGE IN
ELEMENTARY SCHOOL SCIENCE

Ronald D. Anderson
Associate Professor of Science Education
University of Colorado

A paper presented at the annual meeting of the Southwest Region of the Association for the Education of Teachers in Science, Emporia, Kansas, February 14, 1969.

The wide acceptance of new curricular materials highlights a major problem that is glaringly apparent to the perceptive observer of science teaching in our secondary schools and is becoming obvious in our elementary schools as well. The use of new curricular materials does not necessarily mean the curriculum is substantially changed. Basically, the curriculum is the experiences of the students. Just because markedly different materials are used, it does not necessarily follow that the learning activities are substantially different than before the new materials were acquired. The primary determiner of what these activities will be is the teacher, not the materials.

Any of the new elementary school science programs can be utilized by a teacher in a variety of ways. For example, children can be given the opportunity to engage directly in activities with science materials and gain some insights into the nature of science or they can be put on the receiving end of stimuli which come entirely from or through the teacher. The differences are not always that apparent even to the supposedly well informed educator. Which of you has not encountered the principal or even science supervisor who held up as an example of outstanding teaching, a decidedly noninquiry type of teacher, apparently because he was dynamic, had lots of things happening, got along well with the students, or some similar reason? Any science materials can be used in widely differing ways by a teacher, but the differences are not widely understood by practitioners. The teaching strategies employed by the teacher, however, are a major determiner of the curriculum, i.e. the experiences of the students, and the educational objectives which are, in fact, attained.

In this respect, the curriculum reform movement in secondary school science has largely failed. The large majority of the users of the new secondary school science materials do not use them in a manner that is consistent with the stated rationale of the programs. Hopefully, the prospects are brighter in elementary school science. There is a more dramatic difference between the new and the old materials at the elementary level. It is difficult to turn a science lesson into a reading lesson if there are no written materials for the children to read. However, the elementary teacher can still make himself the source of all knowledge and impose his interpretations on the children rather than let them make their interpretations on the basis of data acquired in their investigations. It would seem that the prospects are brighter in elementary school science but there is little concrete evidence that elementary school teachers are making substantial changes in their styles of teaching. How do we know that those shining examples of teaching who we can point to did not teach in much the same way before they got the new materials? All of us like to think that our efforts are producing real changes in the way teachers teach, but are we sure? Statements that we sometimes make like "all of the 1st, 2nd, and 3rd grade teachers in Middle City are now using SCIS" do not actually deal with the realities of curricular change.

An outstanding aspect of science programs such as AAAS, ESS, and SCIS is their consistency with the desired roles of students and teachers in the classroom. But teachers do not assume the desired role simply by "knowing" the materials. Successful programs to foster curricular change must focus on teachers and students and their use of curricular materials; they can not be limited to a study of the materials.

This perspective, though often forgotten, is not revolutionary. It is hoped, however, that this perspective does characterize the program developed by the University of Colorado and Colorado State Department of Education to aid school districts in that state to bring about curricular change in elementary school sciences. Presently operating under funding from the National Science Foundation, through the Cooperative College-School Science Program, the Colorado Elementary School Science Project is now in its second year of operation and is aiding school districts in the intruduction of three programs, SCIS, ESS, and AAAS.

The major thrust of this program is to provide inservice education for elementary school teachers during the time when they first begin to use one of the new elementary school science programs with their children. It is obvious, however, that sheer numbers make it impossible for the State Department of Education and the University to consider providing this inservice education with the personnel which they have available. Because of this, our general approach is to prepare intensively a key group of carefully selected elementary teachers who in turn will train other teachers in the use of the new elementary school science materials.

A description of its first year of operation should show the pattern of cooperation with local school districts and the means by which the program is expanding to other districts.

In the fall of 1967 we got underway with an inservice class focused on ESS for 25 teachers from two school districts taught by James Metzdorf. AAAS was the focus of another class of 25 teachers from a larger school district, Colorado Springs. The instructor of this class was Glyn Sharpe, who along with Mr. Metzdorf constitute the Colorado State Department of Education team of science and mathmatics consultants. Both classes were offered through the University Extension Division and carried three hours of undergraduate college credit for the participants.

Near the end of the semester it was learned that a proposal submitted to

N.S.F. had been funded and a program which had been initiated with state and local funds was expanded at the beginning of the second semester with Federal money.

During the second semester, designated Phase Two, the same groups of teachers continued their work with the new science programs. During this semester the teachers were released from their teaching duties for the equivalent of approximately six days during the semester to attend inservice classes. This greatly facilitated the use of classes of elementary school children for demonstration purposes. Experienced teachers taught children science while the group of 25 teachers viewed the activities from the back of the classroom. Immediately following these sessions the theachers were able to discuss and analysis the teaching that had taken place. In most cases videotape recordings were made of the teaching sessions for later playback for analysis by the group of observing teachers. This focus upon what teaching is in reality, with the opportunity of analysis and evaluation, was a key aspect of the second semester inservice classes. In addition the teachers received assistance in their own classroom while they were teaching. Members of the project staff visited the teachers in their classrooms and aided them in the use of the new materials with their children.

To get the program under way we had to depend upon the few people in the state who had a particular competence in elementary school science and familiarity with the new elementary school science programs. We were fortunate in being able to get some excellent people. We were able to convince Joe Struthers, director of a Title III Elementary School Science Project in the Boulder Schools, to aid us with the Colorado Springs Class during the second semester. Once a week for eleven weeks he traveled to Colorado Springs to work with the group of teachers there. Each time he brought a different elementary school teacher with him who taught the demonstration class of children and provided the example of teaching which the class of teachers analysed on that day. Prior to these afternoon sessions, the two of them spent the morning working with the teachers in their own classrooms while the teachers were teaching science. In addition to this, video tape recordings were made of the teachers while they were teaching for their review and analysis. The ESS classes were conducted by Robert Samples of the Earth Science Curriculum Project and his wife Kris, who is director of a private school. They have both been members of ESS writing teams. Here again, the focus was on the learning of the children.

The third phase of the project was a two week full time session for the 50 teachers last summer. As a result of their year of inservice classes and use of the new materials in their own classes with assistance, it was felt that the teachers had a good understanding of the new approaches to teaching science and could now turn their attention to the problems of aiding other teachers in the implementation of the new science progeams. This was the first time that the two groups of 25 teachers had met together. Since the two groups had been using two different science programs, they now had an opportunity to see a slightly different approach to science teaching. They also had as audience which was not completely familiar with their own approach with whom they could try the techniques they intended to use when intruducing other teachers to the new programs during the coming school year.

The major project of each participant during the two week session was to prepare a plan for a three hour course which they would teach for other teachers during the coming fall semester. They had the opportunity of trying different facets of their plan with small groups of teachers during the two week session. Mr. Metzdorf, Mr. Sharpe, and I as well as an elementary supervisor from each of the districts, were available to assist them. During this time they also participated in laboratory oriented classes which were designed to build up their background in science and a few classes which were devoted to topics such as the findings of psychology as they relate to teaching science in the elementary school, and the problems of implementing curricular change. By the end of the summer program, approximately 50 people had participated in the program, over a period of one year, which first of all gave them extensive training in the use of a new elementary school program and then prepared them to provide such training for other teachers.

The fourth phase of the project consisted of providing inservice education for a large number of teachers by utilizing manpower that had been trained during the previous year. Inservice classes and classroom consultation were provided for over 300 teachers during the fall of 1968 by 15 instructors who were selected from the group of 50 trained during the summer. The approaches used by the instructors of the classes included techinques which were developed and tested during the past year. The classes met after regular school hours but included the observation of classes of children taught by the instructor. The observation and analysis of teaching are an important part of the instruction. Members of the class were also given large amounts of time to work with the materials of their particular science program in preparation for use with the children in their classes. Also, the 15 instructors, but not the members of the classes as in Phase II, were released from their teaching duties for eight days each during the semester to enable them to visit the classes of the teachers whom they were instructing and aid them in the use of the new materials with the children in their own classrooms.

Now that phase four is finished, we have completed our program in the original three school districts. In each district a group of key teachers has been selected, extensively trained, and given the experience of providing inservice education for other teachers under the guidance of the project personnel. Thus, these three districts have a group of teachers who are exceptionally well prepared to provide continuous inservice education within the district under district sponsorship. In addition, a much larger number of teachers have received a good introduction to a new science program including the provision of needed materials for their class and extensive assistance in their use. Thus, in addition to a group of well prepared leaders, the district has made a good start on encouraging curricular change and has established a pattern which can be continued in the future. The inertia which slows change has been at least partially overcome and the districts also have the necessary resources to continue their encouragement of this change.

Phase four has also provided the basis for expanding the Project to other school districts. Approximately one half of the 300 teachers in the Phase Four inservice classes were from the three districts which were involved in the Project from the beginning. The others are from eight school districts in which we are beginning the same cycle of activities which we have just completed in the original three districts. Phase four of last year's program has served as Phase One of the next year's program. We recently received word that the NSF has awarded a grant to the University to conduct the program in these eight new school districts.

Now that the activities of the Project have been outlined, let us look at some of the principles upon which the program is built.

1. As previously indicated, we are employing a multiplier feature to enable us to reach large numbers of teacher. Sheer numbers make it impossible to consider providing inservice training for the majority of elementary school teachers in the State with the specialists who are presently available.

The impact of the group of teachers whom we trained to teach other teachers has not ended with their instruction of the 300 teachers this past fall. They have the potential of working with other teachers in future semesters in their own school district as well as neighboring districts.

2. Because of the number of people involved and their wide geographic distribution we must pay particular attention to a second principle - quality control. All of the teachers enrolled in classes taught by the instructors whom we trained are receiving undergraduate college credit which further increases our need to be concerned with the maintainence of standards. There are three factors that we depend upon for this quality control: (1) the extensive training which has already been mentioned, (2) selection, and (3) supervision.

The selection of instructors occur in three stages. The first selection takes place when the districts select the teachers who entered Phase One. Further selection occurs when the Project personnel, in cooperation with personnel from the school district, select those who will continue into Phase Two. Finally, of the people who complete the one year training program we only choose about one-third to be instructors of inservice classes. The training of the others is not wasted since they serve as resource leaders in their own school.

Our third means of quality control is close supervision. During Phase Four, a full time supervisor worked with the 15 instructors. The supervisor, Jerry Horn, provided assistance for the instructors, such as obtaining materials and provided counsel and advice. The supervisor has the final authority on decisions pertaining to requirements and standards.

3. The program is also built on the principle that the districts themselves must take the major responsibility for implemention of curricular

change. The districts select the elementary school science program that they want and share in the cost of the inservice education program which we direct. Now that our program with the initial three districts has been terminated, we expect that they will continue the introduction of new materials and inservice education of teachers which has been started. The task is not complete in any of these districts but they now have the experience and trained personnel which will enable them to continue the job on their own. We have offered assistance to these districts but the major responsibility is still theirs.

There are problems, however, in establishing the proper relationship between the Project activities and the local school district curriculum development procedures. These problems are largely, I believe, a reflection of the tensions resulting from nation wide changes in the means of curriculum development. School districts need to evaluate their curriculum development and revision procedures. In the case of our project, school districts need to have sufficient knowledge of AAAS, ESS, and SCIS to enable them to make an intelligent selection of the program which will be used in the Project activities in their district. Because of the extensive investment in materials necessary for participation in the Project activities (the equipment is funded by the cooperating districts), the use of a specific program in the Project activities almost completely commits the district to adoption of that program. To at least partially alleviate this problem we hope in the future to provide as much "lead time" as possible for districts to study elementary science curricula prior to their entry into Project activities. We will encourage them to obtain extensive information and advice on curriculum revision and, whenever possible, have several trial classrooms where the materials of SCIS, AAAS, and ESS are being used and examined prior to making a committment to one program.

4. Another viewpoint which I hope permeates what we are doing as much as possible is the principle that teachers play the central role in implementing curricular change. Although this may seem so obvious that it deserves little mention, it is apparent that the implementation of curricular change has often suffered from failure to recognize this principle. Programs of curriculum revision cannot be organized for teachers "from the top down" by the administrators and/or supervisors. Particularly in this day of new and excellent science materials, it is easy to focus on the materials and neglect the teachers who use them. It is not enough for a teacher to "know" a new program; he must know how he can use the materials effectively in his class in a manner that is consistent with himself, as a person.

We cannot afford to forget that the experiences of the students are the real curriculum of a school. What children do in school may or may not be consistent with the printed materials and guides which the teacher and children use. It is not possible to tell what the children's experiences are by examining the school's curricular materials. It is possible to determine what position the developers of the materials have taken with respect to choice of content, choice of organizational pattern and generally, the selection of learning activities as well. What the curriculum is in fact, however, is determined by the teacher. Two different teachers may both be using a set of curricular materials in the manner which they perceive to be the intent of the developers of the material, and yet be directing the learning of children in quite different directions. The teacher is the determiner of what the curriculum is in his class.

A much overlooked fact is the large individual differences in teachers. Most programs of curriculum materials development, as well as teacher education programs, give major importance to "the teacher" but fail to make sufficient allowance for the fact that "the teacher" is a different person in each classroom. Some teachers are most effective in a class that has so much student activity of diverse kinds in a different places in the room that it may give the impression of chaos, while other teachers simply are not able to cope with such a situation. Some teachers are not able to teach science very effectively without materials that give them quite specific directions, while others feel restricted by such materials. Some teachers are more convinced of the importance of certain cognitive objectives while the values of other teachers are focussed more upon certain affective objectives. Many more examples could be given which would serve to illustrate the fact that there are large individual differences in teachers and these differences result in different curricula, i.e. different learning experiences for their students.

In spite of the fact that there has been extensive development of curricular materials at the national level in recent years, it is apparent that teachers must be provided with the assistance they need to make effective use of these materials before a school district will have a "good" science program. Because of this viewpoint, we have attempted, as much as possible, to focus our inservice instruction on the use of the new materials in actual classroom situations. This is the reason for having children involved in the inservice classes and the reason for working with the teachers in their own classes while they are teaching.

An initial evaluation of our program, as well as other current curriculum implementation efforts, from this perspective raises many important questions. Should we be satisfied with the fact that teachers have no opportunity to select the materials which they will use but must use whatever materials the district has selected? Although both are designed to teach an understanding of the nature of scientific investigation, the ESS and AAAS programs are quite different in what they require of teachers. Yet, teachers have no chance to select those materials that are best suited to them. To what extent should we attempt to give teachers a style of teaching that is derived from the materials that are being introduced and to what extent should it be derived from what the teachers are as individuals? To what extent are student outcomes determined by course content and to what extent are they determined by the teaching strategies employed by the teacher? These questions and a host of others need intensive study by scholars and careful consideration by practitioners.

Up to this point I have implied, if not stated directly, that we have been successful in implementing curricular change. Actually, at this point, there is little evidence to go on, other than the opinions of the participants. Participant opinion as determined by anonymous questionaire, has been very positive. We are in the midst of a more sophisticated evaluation, however, which includes an analysis of the teaching of teachers before and after their involvement in the program. A research design has been devised that will enable us to study the relationship of several teacher variables and teaching style along with out evaluation of the project. In September video tapes were made of 28 teachers who were selected at random from participants in Phase IV of the program. All these teachers were teaching their own class while using materials which we provided for them for the purpose of the evaluation. After they had completed the semester's work a different 28 teachers, selected randomly from the participants, were videotaped under the same conditions. We will now analyze the teaching with the aid of a system that Joe Struthers has developed, to determine what changes in teaching style have occured. We will then be in a better position to say what impact we have had on the real curriculum of the schools.

After a year and a half of experience with this approach, I feel that we have developed a feasible model of how we can aid shcool districts in implementing curricular change in elementary school science. Our problem now is to expand the program. We began the program in the fall of 1967 with the ESS and AAAS materials but this past fall we were able to expand the project to include the materials of the science curriculum improvement study (SCIS). Thus, we are now preparing teachers to use all three of the major new curricular programs. Glenn McGlathery, who recently joined the faculty of the School of Education and Jim Metzdorf spent a week in Berkley at the SCIS headquarters last fall to become more familiar with that program. This week at Berkley, along with their previous experience with SCIS, assures that we now have personnel who are well acquainted with the materials of all three of the major new programs, along with having general expertise in elementary school science teaching.

Our major problem now is developing a means of making this kind of assistance available to all of the districts in the State of Colorado that want it. The wide geographic distribution of teachers in the state is a major difficulty and funding could be a serious problem with federal sources being as uncertain as they are.

We have modified our model slightly to enable us to reach the more remote districts of the State and are now ready to inform districts across the state that the Project is now open to any district. An additional four years of funding at our current level should enable us to provide every district which desires it with the level of assistance which we have provided in the districts where we have just completed our activities. Assuming that districts including 85% - 90% of the teachers in the State will desire the assistance, it will require the initial training of 3000 teachers (about ¼ of the teachers in each participating district) and the preparation of instructors who can continue the inservice education in those districts after the Project terminates its activities there.

In conclusion, I would like to comment on two matters which have become more apparent as the result of involvement in these activities. Agencies which provide assistance and service to schools need to evaluate their efforts and determine whether or not their work is having an effect where it counts - in the transactions of the classroom. For example, I believe Mr. Sharpe and Mr. Metzdorf from the Colorado State Department of Education have been particularly farsighted in interpreting their role as science and mathematics consultants. They have been willing to spend great amounts ofextra time and effort to provide assistance to schools that has been very helpful but is not in the tradition of state departments, at least as I have known them. They are convinced that meaningful changes in schools will come about only as the result of changes in what teachers do in the classroom. Because of this, they have expended great efforts in working directly with teachers and in fostering programs, such as our joint effort, in order that assistance can be provided to schools at the level where it will have major impact on what students experience in the classroom. In my opinion, state departments of education would do well to allocate a much larger portion of their resources to such efforts than they have in the past.

Finally, it is becoming increasingly apparent that the process of curriculum development at the local level needs a great deal of study. The curriculum development work at the national level has not had the effect that its initiators had desired and expected. Pre-service teacher education is currently being discussed in many quarters and every indication is that extensive efforts will soon be devoted to bringing about major changes in pre-service teacher education. These activities, and many others, are of great importance, but they largely occur outside of the elementary and secondary schools where the "real action" is. Local school districts, on the other hand, are generally employing curriculum development processes that originated long before the arrival of curriculum development projects at the national level and at a time when teachers were neither as competent nor as militant. Many recent publications on curriculum development, e.g. NSTA's Theory Into Action, have attempted to bridge the gap between the national and local curriculum development endeavors, but little attention has been given to the problem of directing all of these efforts toward fostering curriculum development at the point where it actually occurs - in each classroom.

RESPONDER

Dr. Leo Mahoney
University of Houston

I'm happy to be here in Emporia. A Special thanks to Bill LaShier, Mrs. Twyla Sherman, and the Transportation Committee.

RESPONSE TO DR. RON ANDERSON

Ron: Thank you for presenting such an informative paper on "Encouraging Change in Elementary School Science."

In response to your paper, I concur that the critical issue in the newer science programs is the Classroom Teacher. I note some problems we must solve in this regard.

Problems to Solve in This Regard

Our evaluation of our CCSSP (College Cooperative-School Science Program.)

If a teacher has been exposed to, or even completely understands, the philosophy, rationale and can and has been demonstrating Inquiry teaching, this is no guarantee that she will use it in the classroom in the manner prescribed.

It appears, therefore, that the massive effort by scientists and science educators to design entirely new curricula in every field and in every level of science may fail unless we rethink, rewrite, and revise the present teacher education program.

Currently, the place to begin, in my judgment and limited experience is the pre-service or undergraduate course in science. These efforts, however, may fail initially because the scientists have not included in their planning, at least initially, the science educators and representatives from the public schools.

The next effort of this redirection program is the teacher education phase at the undergraduate level along with similar plans or programs for the classroom teacher. I am specifically referring to the science methods courses. Also, we should involve these key persons in the planning, directing, and evaluation.

The new interest which psychologists and sociologists are showing in classroom teaching and learning is encouraging; in that it will be possible to base teaching on a sound theoretical foundation.

The values of the new Inquiry based programs have not yet been proven by educational research. Many studies underway have only yielded ambiguous results. I'm sure many of you have undertaken such research models and may soon have the data available. However, it appears many of us are busy inaugurating new programs and have not yet had this opportunity.

IN CONCLUSION, may I bring a word from our scheduled speaker, Dr. Howie Jones. He asked me to include this point.

> When engaging a school system in a newer curricular plan, mold the plan around the philosophy of the local school system; involve all school personnel available, administrators, supervisors, and teachers; Try not to change the aspects of their programs that do not need changing; build upon their strengths when incorporating the curriculum changes.

Lastly, the major question many school administrators present: "It sounds good--looks good, but how do you know it will work in my school system?"

THE DALLAS JUNIOR SCHOOL PROJECT

Paul J. Cowan
Denton, Texas

In 1961 the Texas Education Agency recommended that junior high schools in Texas teach the following sequence of laboratory oriented science courses: Grade 7 - Life Science; Grade 8 - Earth Science; Grade 9 - Physical Science. Junior high schools which have made efforts to implement these recommendations have discovered that the demand for teachers with adequate preparation in these areas, especially the physical sciences, far exceeds the supply. In their attempt to rectify this situation, officials from the Dallas Independent School District met with representatives from North Texas State University to discuss possible ways to improve the 9th grade science course taught in the Dallas junior high schools. This and subsequent meetings resulted in the preparation of a proposal and its submission to the CCSS program of the National Science Foundation for funding.

Program Outline

Phase 1. Each participant was required to attend a one-week pre-school workshop in August, 1967. An attempt was made during this workshop to acquaint the junior high school science teachers with the philosophy and methods of the chemistry and physics courses being taught in the high schools of Dallas. Many of the high schools use CHEM Study chemistry and PSSC physics.

Phase 2. During the academic year a series of 32 in-service meetings was conducted for the purpose of improving the subject matter understanding in the physical sciences of these teachers and for the purpose of examining the new programs in physical science now available commercially. The last 8 weeks of this phase was devoted to an intensive examination of the five junior high physical science texts placed on the adoption list by the State Board of Education. The particular text(s) selected by the teachers of Dallas will be in use for a period of five years.

Phase 3. Twelve of the participating teachers were invited to attend the 4-week summer writing conference held on the campus of NTSU during the summer of 1968. Only those teachers in the program that demonstrated unusual and/or creative abilities were invited to attend this phase of the CCSS program. The actual writing of content material was done by the junior high teachers. Scientists and consultants from the physics and chemistry departments at NTSU were used to edit and attest to the accuracy of the materials. A 168 page laboratory manual resulted which is being used (1968-69 school year) in all junior high schools in Dallas.

Discussion

During the year preceding the operation of this program, a status study was conducted in order to find out information which would be helpful in making plans for the operation of the CCSS program. It was discovered that many teachers were dissatisfied with the set of laboratory exercises they were using.

Consequently, very little time was being used for activities related to the laboratory. Most of the teachers time was being spent amplifying the material found in the text. The following comment from one project teacher seems to express the feelings of the others in the program.

> "The main criticisms that I have against the laboratory experiments are that they are written in such a technical way that my students have a hard time reading them, let alone understanding what the directions say. In many cases, the math was too hard for them. They all seem to have a very weak background in math. Therefore, I suggest that many of the experiments be simplified."

It was found that, on the average, less than one 45 minute period per week was devoted to laboratory experiences. Therefore, it was decided that one way to improve the existing program was to encourage teachers to devote more time to the laboratory.

During the one-week pre-school workshop held for these teachers an attempt was made to orient them in the philosophy and methods of both the PSSC and the CHEM science programs. This proved to be a poor use of the time. Looking at this part of the program, the director now realizes that better use of the time could have been obtained by not trying to do so much in such a short period of time.

The in-service meetings held during the academic year were conducted at a centrally located junior high school in Dallas. The first few sessions were devoted to an examination of several of the available junior high physical science programs. Fifteen sessions were used to study in detail the IPS program. It is interesting to note here that the participants would be ready for a "coffee break" about 8:15 P.M., or about 1½ hour after the session started. However, the interest in the first IPS session was so intense that it was 9:15 P.M. before anyone mentioned that we had not taken a break. Attendance at the in-service sessions was almost 100% during the time the IPS program was being studied.

Since this was the year for Texas teachers to select a physical science text, the last few sessions were devoted to an examination of the five available texts. The director expressed some disappointment because the selection in Dallas only allowed for 10% adoption of the text Introductory Physical Science. On the other hand, at this stage in the program, participating teachers were beginning to change their way of thinking concerning the relative emphasis on laboratory activities. Most admitted that they were spending much more time engaging their students in laboratory activities and were getting excellent results. Some expressed the opinion that by guiding their students in laboratory experiments, student interest increased and remained at a high level. Some indicated that they would spend little or no time lecturing students again.

Each participating teacher was required to prepare a "favorite" laboratory experiment which reflected the spirit of inquiry. On the basis of these papers ten participants were selected to participate in the summer phase of the CCSS program. Although the desired creative efforts seemed to be missing, it was apparent that these teachers had put much effort into these experiments. These experiments were duplicated and each teacher given sufficient quantities so try them in their own classes. These experiments were based on their adopted text.

In many respects the summer phase of the Dallas Junior School Project was most profitable. Participating teachers selected a person to work with and each group of two was assigned an area of physical science to study. Complete freedom of library facilities and equipment facilities of both the physics and chemistry departments was enjoyed by participants. Their assigned responsibility was to produce three or four laboratory exercises that would be appropriate for students in the Dallas school system. At the end of each two day period, each group met with the others for the purpose of criticizing each others work. The laboratory experiments were then to be re-written and then submitted to the consultants and scientists working with the program for review.

One individual (a lady) cried when her work was "torn apart." This sort of give-and-take caused some hard feelings among participants. This, however, only served to make the individual resolve to do a better job the next time. By the end of the summer phase, participants became quite close even though they pointed out serious flaws in each other's work. This, I think, represents a bit of evidence of professional growth on the part of junior high school teachers

The end result of the summer's efforts was the production of a 168 page student edition laboratory manual based on the textbook used by the teachers. The Dallas Independent School District has published this manual and it is now used by all students taking 9th grade physical science in the Dallas system.

Follow-up

The effectiveness of a program like this is best measured after the formal class sessions have ended and the teachers have gone back to their classrooms. A survey taken during the first semester after the close of the program revealed that teachers in the program had spent more than three days per week, on the average, conducting laboratory sessions with their students. This represents an increase of about 300% over the year just prior to the program. In fact, teachers not in the program showed an increase of laboratory time of nearly 200%.

Local in-service meetings are being conducted by the teachers who participated in the program. Perhaps this accounts for the increase in lab-time of the non-participating teachers. The fact that there is a continuation of the work started during the active phase of the CCSS program, is evidence that the time and effort that went into it was not in vain. Many lessons were learned by the director on how to conduct and how not to conduct such a program. Although this model is not a very good one, it does contain some elements that may be of worth to others.

SCIENCE AND MATHEMATICS IN-SERVICE TRAINING
IN KANSAS - SPRING 1969

Dr. Glenn Crumb, Kansas State Teachers College

First, it is necessary to point out that my remarks will be confined to a series of elementary school programs with which those of us at Kansas State Teachers College have been involved. This is not to infer that other programs are ineffectual or do not represent major contributions to in-service education in the State. Each effort has been welcomed by the schools and every effort needs more support. By limiting my comments to Kansas State Teachers College related projects it is possible to relate to you first-hand impressions and observations gathered over the past three years.

To further set a reference for my remarks I wish to use "Classification Schema of Processes related to and Necessary for Change in Education" developed by David L. Clark, Ohio State University.[1] The Schema consists of "three phases" which are carefully outlined in terms of "objective", "criteria" and "relation to change". Some modification in terminology has been made as the schema has been used, but the original concepts remain unchanged.

It is, I believe, a fair assessment to state that the "Research" and "Development" aspects outlined in "Phase I" for elementary school science and mathematics curricula has been or is being accomplished already. This statement is made with an understanding that curriculum development ought to be a continuous process. A static curriculum is a stagnant and impotent one.

In reference to Phase I, let me point out such objectives as "to advance knowledge", "to innovate" and "to engineer", as being appropriate to the science of curriculum building or revision. Likewise, such criteria as "validity, impact and performance" have already been applied or are currently being applied in some of the more promising curriculum projects. In-service training programs with which we have been involved at K.S.T.C. satisfy the essentials of Phase I.

In Phase II of the schema we note the process of "diffusion". The objectives here are "to inform" and "to build conviction" and the criteria of fidelity, pervasiveness, credibility, convenience and evidential assessment are brought into play. The relation to change being to inform about the invention and to build conviction about the invention. At this point one other thing needs to be injected before discussion of K.S.T.C. related projects. This has to do with the selection of a curriculum or curricula "to push", to inform about or build conviction about, as you will. As far as the various science curricula are concerned let me say that AAAS, SCIS, ESS and the Minnemast project materials contain elements which are compatable with my personal philosophy of what constitutes good teaching of science in the elementary school.

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[1] David L. Clark, U.S.O.E. Cooperative Project #Y002, Ohio State University, June, 1966.

The mathematics materials being evolved or used by David Paige and Bob Davis and those of the Nuffield Project and Minnemast project are similarly aligned with my own ideas, although the latter two sets of materials do not in my view constitute an elementary school curriculum per se. I will not be drawn into the diurnal coffee shop arguments here about the relative merits of any of these projects. Suffice it to say that if any combination of these math and science curricula materials were adopted state-wide and properly taught a major improvement would occur. No panacea, just a major step in the right direction, in my opinion at least.

On this map of Kansas are indicated three separate and distinct elementary science curriculum projects which will be the center of my further discussion.

The youngest and thus the one possessing a great deal of potential is that for the area to the north, west and south of Wichita called the South Central Kansas Science Math Project (SOCKAN Math-Science Project). This project is funded through a ESEA Title III (P.L. 89-10) grant to Mulvane School district. The project is designed to bring about improved teaching of elementary school science and mathematics for schools with pupil population of about 14,000 children (1-6). So far as the classification schema is concerned all that can be said is that phase II waits in the wings. Although money (lots of It) helps to "sway" superintendents and teachers, there has been some "weighing" too. The latter being based upon the diffusion objective of information with criteria of intelligibility, fidelity, pervasiveness and impact. Most of the data available to the superintendents of this area has come from two other federal projects in Kansas, namely the KEMS project and the Flint Hills project.

In the KEMS project we have 34 teachers located in the centers indicated on this map. The prime purpose of these teachers was to provide an avenue for informing teachers and administrators about the invention and then to demonstrate for them in-their-school in order to build conviction. This has been accomplished by providing teacher, in-service summer training, helping the participants to obtain equipment, then reinforcing their own teaching efforts by follow-up sessions in their school and on campus.

The second step for this project, in the diffusion process, was that of demonstration teaching before teachers of the school and/or district where the participant is employed with a follow-up informational meeting with parents groups or the PTA. These two tools, using video-taped sequences of home school children working with new curriculum sequences has been extremely effective in getting public support and in melting the icy walls between participating teacher, her peers and the school administration. The technique is expensive both in dollars and time. However, some major communication links have been opened between schools, the staffs of the state college and the State Department of Public Instruction curriculum section. I believe it is a fair assessment to state at this time, that evidence can be provided to support the contention that essentially all project schools are in the latter stages of phase II with some approaching the end of phase III.

Fortunately, there is another aspect which has helped and that has been a very concerted effort of project staff to develop favorable public image and public information through the news media in the various communities as well as regionally and statewide. Since the project is past mid way it would be unfair to hold out for too much more in prospect for the project beyond these factors:

(1) Communication lines have been opened and are becoming well established between college, staff, school administrators, and State Department of Public Instruction curriculum personnel.

(2) College pre-service programs have been greatly influenced to the point of revolutionizing some of the curriculum offerings.

(3) College in-service offerings have been expanded to a point where personnel limitations are becoming a governing factor. (Demand by schools exceeds leadership capabilities.)

(4) Intra college ties between education and science staffs as well as inter college ties between the faculties of state schools have been made and are being recognized by Deans, Presidents, and the Regents. (How long they will last is not known.)

Contributing to these things as a ground breaker, ice melter or snow blower has been the Flint Hills Elementary Science Project which was designed to bring about curriculum improvement in grades 5-8 of the schools within the area indicated by cross-hatching in east central Kansas. Involving 13 rural unified school districts in the immediate area surrounding Emporia the project had as its first hurdle the dissolution of problems within individual districts. These problems were remnants of feuds of by gone days fueled by sports, rivalries, personal animosities and what have you, until brought to a boil by a statute requiring unification of districts under one central administration. Amazing as it might seem, by throwing a representative teacher or two from each school building together in a five-week science workshop followed-up with in-service help sessions on one Saturday a month new boundries that were drawn had much less significance. School and public relationships improved to a fantastic point of mutual cooperation.

This inservice project has in all cases taken the schools into phase III. There has been some incidents of major regression due to personnel loss or shift, but in the main, Flint Hills project teachers teach differently. The following are positive indications, data if you please, to support this contention:

(1) As a result of grade eight adoption of IPS students demanded something "more than general science".

(2) Steps were taken in at least half of the schools to up-grade science in the first year of the 4 year high school program by adopting ESCP with support of a NSF college-school cooperative project.

(3) Major shifts of emphasis and priority in purchasing of equipment and materials for elementary school science occurred.

(4) Some schools moved to an intermediate school structure (6-8) in order to utilize the personnel developed most effectively.

(5) Schools have 5-day a week laboratory science programs for one full year each in grades 6-8 where formerly little or no science was taught.

(6) A science program in grades 1-4 was requested and will be started next fall under an NSF grant to K.S.T.C. to be directed by Dr. William LaShier.

Clearly these schools are in phase III and more specifically in the installation or institutionalization aspects of adoption of further importance are the facts that science teaching in all levels has been somewhat influenced and that the school boards and school administrators are agressively pursuing curriculum reform at other levels in science and in other subject areas pre-school through grade twelve.

This progress report does not contain the hard statistical data to support it. Neither does it contain a review of the many problems encountered in the past, present and forseen at this time but not solved. However, the following statements are appropriate with regard to rural school population, teachers, administrators and publics in Kansas:

(1) Local pride can be a major deterrent to progress - we hate to admit we have been wrong for so long.

(2) Similarly, pride can be a major positive force in curriculum change since rural people are becoming aware that there is little to offer youth "down on the farm" except a good education.

(3) Rural school districts do have the flexibility budgetwise to implement a new curriculum and will obtain the needed materials to do so.

(4) Rural school boards and administrators can and will establish new educational priorities in order to improve the educational opportunity for their youth.

(5) Groups of rural school districts in a voluntary consortium group can cooperate effectively and cordially to accomplish ends beyond their individual means.

(6) New administrative leadership needs are being recognized, i.e. principals who are supportive of curriculum development cannot be tied down with paper work, custodial duties and bus schedules.

(7) Rural schools look to colleges for real help and are appreciative of it.

The future looks bright-or dim-whichever you may choose. Some major rumblings are being heard about the state. If a concerted effort is maintained to develop regional and state-wide leadership the schools could become a hotbed of major change in instructional mode or practice. Project teachers seem to enjoy the new freedom provided by the science curricula; freedom to work with children who are learning. They see the fallacy of children reading about science and failing to comprehend because they cannot read or are unable to bridge the gap between the real world and the vicarious experience provided through the printed page or lecture.

In closing, I will hasten to ask myself whether or not my college and university colleagues are listening.

PHASE I

A CLASSIFICATION SCHEMA OF PROCESSES RELATED TO AND NECESSARY FOR CHANGE IN EDUCATION

	RESEARCH	DEVELOPMENT	
		INVENTION	DESIGN
OBJECTIVE	To advance knowledge	To formulate a new solution to an operating problem or to a class of operating problems, i.e., to innovate	To order and to systematize the components of the invented solution; to construct an innovation package for institutional use, i.e., to engineer
CRITERIA	Validity (internal and external)	Face Validity (appropriateness) - - - Estimated Viability - - - Impact (relative contribution)	Institutional Feasibility - - - Generalizability - - - Performance
RELATION TO CHANGE	Provides basis for invention	Produces the invention	Engineers and packages the invention

PHASE II

A CLASSIFICATION SCHEMA OF PROCESSES RELATED TO AND NECESSARY FOR CHANGE IN EDUCATION

	DIFFUSION	
	DISSEMINATION	DEMONSTRATION
OBJECTIVE	To create widespread awareness of the invention among practitioners, i.e., to inform	To afford an opportunity to examine and assess operating qualities of the invention, i.e., to build conviction
CRITERIA	Intelligibility - - - Fidelity - - - Pervasiveness - - - Impact (extent to which it affects key targets)	Credibility - - - Convenience - - - Evidential Assessment
RELATION TO CHANGE	Informs about the invention	Builds conviction about the invention

PHASE III

A CLASSIFICATION SCHEMA OF PROCESSES RELATED TO AND NECESSARY FOR CHANGE IN EDUCATION

	TRIAL	ADOPTION	
		INSTALLATION	INSTITUTIONALIZATION
OBJECTIVE	To build familiarity with the invention and provide a basis for assessing the quality, value, fit, and utility of the invention in a particular institution, i.e., to test	To fit the characteristics of the invention to the characteristics of the adopting institution, i.e., to operationalize	To assimilate the invention as an integral and accepted component of the system, i.e., to establish
CRITERIA	Adaptability - - - Feasibility - - - Action	Effectiveness - - - Efficiency	Continuity - - - Valuation - - - Support
RELATIONS TO CHANGE	Tries out the invention in the context of a particular situation	Operationalizes the invention for use in a specific institution	Establishes the invention as a part of an ongoing program; converts it to a "non-innovation"

MANPOWER DEVELOPMENT

David P. Butts

Science Education Center
The University of Texas

and

Science In-Service Project
Curriculum Demonstration Center

MANPOWER DEVELOPMENT

David P. Butts

Science Education Center
The University of Texas

and

Science In-Service Project
Curriculum Demonstration Center
Austin Independent School District

Securing change in the learning experiences of students has been the ultimate goal of curriculum innovations in mathematics, science, and more recently social studies and linguistics. These curriculum innovations represent the combined talents of teams of academicians, classroom teachers, and learning theorists. The existence of these curricula does not, however, mean that students' learning experiences have in fact been changed. Spanning the development of the curriculum innovation to its institutionalization represents the challenge of our day. This challenge can only be met by the development of the adequate base of manpower. This statement is based on the simple assertion that people plus programs equal change, whereas programs without people remain on the supervisor's office shelf!

Change in the student's learning experience can be facilitated through the way those experiences are structured. The structure of the learning experiences includes both the curriculum and the teacher who uses that curriculum. The nature of the newer curriculum innovations are such that effective use of them requires an understanding of both the subject and the method that was built into the design of the program. To use the innovation effectively, most teachers find it necessary to considerably modify previous teaching procedures. Teachers can no longer "teach as they have been taught." They can no longer just have the students copy notes in their notebooks presented largely from the teacher's old college notebooks!

The effectiveness of curriculum innovation is directly dependent upon the preparation of the teacher. Where, how, and when is the teacher to secure this preparation? Change on the part of the teacher is at least dependent upon the degree and amount of administrative support for that change and the opportunity to experience and practice the "new look" in the role that the teacher plays in the classroom. The opportunity for experience and practice must be part of the teacher education program directed by competent leadership staff. Initially this leadership staff may come from outside the school system. Eventually, however, if change is to become a part of the system, the source for change must be part of the home base.

To initiate change in the home base, however, one approach has been to structure awareness conferences in which the decision-maker has the opportunity to secure information about curriculum innovations. The second step in this implementation model is the demonstration setting in which the decision-maker can examine further the changed classroom procedure and ask questions of the user. Based on these two sources of information, the decision can then be made to initiate adoption or to initiate no change.

If adoption is initiated through the decision-maker, there appears to be a third relevant step, to pilot test the innovation in the local situation. Here the local experience will provide insight as to the adequacy of the teacher education program, the appropriateness of the curriculum materials for students, and the capability of the local school system to support the logistics required by the innovation. This step usually requires the assistance of outside resources to direct and guide the pilot use of the curriculum innovation.

A second step is the installation of the program within a system which includes both the development of local leadership for the implementation of the curriculum innovation and the development and adaptation of the curriculum innovation itself to meet local conditions. Dependent upon the size of the system and the amount of resources, the installation process may take from two to four years.

The final phase of implementing a program, its institutionalization, is one in which the means are provided for the continued training for new members of the teaching and administrative staff and effective utilization of the curriculum innovation.

Figure 1 incorporates the three phases of implementation with their relevant decision points. In this Figure, the nomenclature used is:

S = student

T_1 = teacher

T_2 = local leadership staff

T_3 = regional resource staff or staff of a local college

A MODEL FOR IMPLEMENTATION

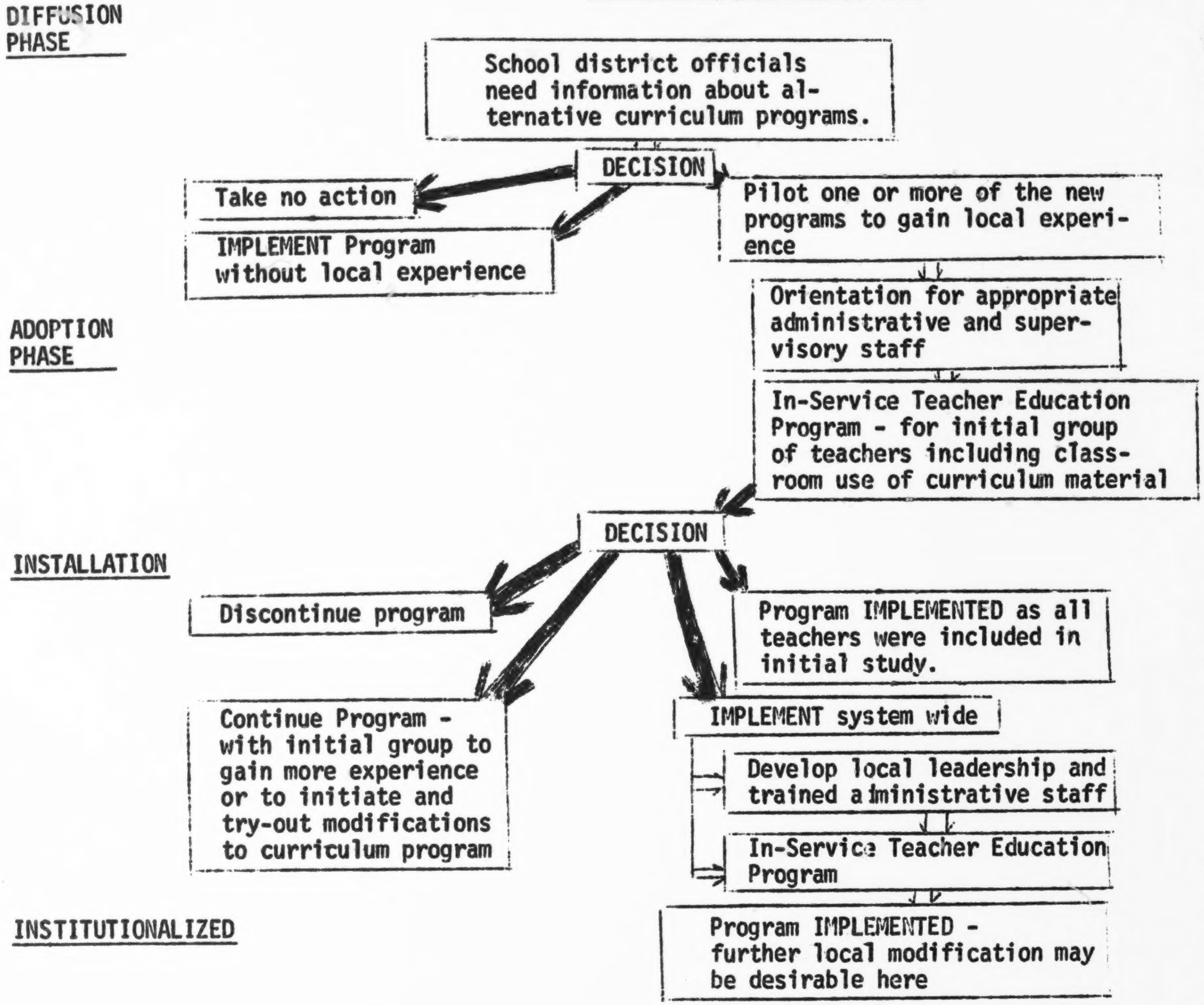

DIFFUSION PHASE
School district officials need information about alternative curriculum programs.
DECISION
Take no action
IMPLEMENT Program without local experience
Pilot one or more of the new programs to gain local experience
ADOPTION PHASE
Orientation for appropriate administrative and supervisory staff
In-Service Teacher Education Program - for initial group of teachers including classroom use of curriculum material
DECISION
INSTALLATION
Discontinue program
Program IMPLEMENTED as all teachers were included in initial study.
Continue Program - with initial group to gain more experience or to initiate and try-out modifications to curriculum program
IMPLEMENT system wide
Develop local leadership and trained administrative staff
In-Service Teacher Education Program
INSTITUTIONALIZED
Program IMPLEMENTED - further local modification may be desirable here

FIGURE 1

Manpower Function

1. T_3 provides information.
2. T_3 conduct teacher education program for administrators.
3. T_3 conduct in-service teacher education program for pilot teachers. T_1
4. T_3 serve as consultant during the school year to T_1.
5. T_3 assist school district in planning next steps.
6. T_3 conduct Leadership Teacher Program for T_2.
7. T_3 coordinates teacher education program where T_2's work with T_1's in a school district.

A. THE SCIENCE IN-SERVICE PROJECT - WHAT IS IT?

With curriculum programs now developed or in the process of being developed, the decision-makers of local school districts need both sources of accurate information and opportunities to examine the programs in operation. One effective source of this information is the staff of Regional Service Centers who have been trained in both the curriculum innovation and in communicating its progress to others. To assist the Regional Service Center staff, classrooms within the region where the program is in operation have become a most relevant tool of communication. Therefore, one objective of the Science In-Service Project has been to:

> Provide information about curriculum innovation through both awareness conferences and demonstration classes.

Based on the information gained in the awareness of the program and the opportunity to observe it in action, the decision-maker can then initiate steps for implementation. Three concerns become evident. (1) Is the curriculum innovation appropriate for the students in the district? (2) Is the competence required of teachers within the range of local staff? (3) Will the local resources be adequate to provide the necessary support for equipment, etc.? To assist in providing answers to all three of these questions, a pilot study provides local experience and data on feasibility. Leadership is needed from outside the district in designing and carrying out the pilot study. Regional Service Center staffs here can be a functional answer. Therefore, a second objective of the Science In-Service Project has been to:

> Demonstrate curriculum innovations in local districts through pilot studies which includes both a model in-service teacher education program and an opportunity to assess district support for change.

From the viewpoint of the decision-maker, there must be a source of initial stimulation for change. While initially this comes from outside the district, if the change is to become institutionalized, it must be based on leadership within the district. Thus when the decision is made to implement a program, there needs to be a means whereby local leadership (T_2's) can be developed. A third objective of the Science In-Service Project is:

> Conduct leadership training and coordinate follow-up activities for staff of districts or service centers.

Basic to improved curriculum is the awareness that there is probably no one way to accomplish this important task. For example, experience during the past five years has illustrated that T_3s may be effectively developed for either Regional Service Centers or local colleges and universities. Providing them with a leadership development program has made it possible for more than 60 members of both groups to serve in the T_3 roles throughout the state of Texas. The potential sources for T_2s are also illustrated in a variety of alternatives. In many instances, effective classroom teachers have been able to function as effective T_2s when provided with appropriate leadership development training. In other cases, a high school science teacher or an elementary principal or supervisor have been trained to serve in the T_2 role.

When in-service programs are considered, there are a series of alternatives possible through which both pilot programs can be initiated and implementation programs can be structured. As an illustration of the flexibility, the following plans have been used:

A. Summer workshops for volunteer teachers, three weeks long, morning-only sessions, with monthly after-school follow-up meetings.

B. Summer workshops with volunteer teachers, three-week sessions, full day, with no follow-up schedule.

C. Summer workshops, volunteers or stipends for full-day sessions of one week with six follow-up meetings scheduled during the school year.

D. Summer workshop with volunteers or stipends for five half-day sessions with or without follow-up schedule.

E. Summer workshop for two days with six full days of released time scheduled during the school year.

F. Summer workshop of six weeks, full day with stipends and follow-up as needed scheduled during the school year.

G. Released time during the school year of 11 half-days.

H. Released time during the school year with eight half-days.

I. Released time during the school year of seven full days.

J. Released time during the school year of five full days.

K. After-school in-service program of 30 one-hour sessions.

L. After-school program with eight sessions.

M. An academic institute of 18 evenings of two-hour sessions each week.

The leadership development program for T_1, T_2, and T_3 are being developed for various curricula by the Research and Development Center on Teacher Education at The University of Texas. The Science In-Service Project has provided a context in which alternative approaches to leadership development and in-service teacher education have been under development. Thus, a fourth objective of the project has been:

> Develop alternative approaches to leadership development and teacher education.

B. THE SCIENCE IN-SERVICE PROJECT. WHAT IT HAS BEEN DOING IN MANPOWER DEVELOPMENT.

Experience in the use of one curriculum innovation, Science - A Process Approach, a science program for elementary school children, has indicated that the development of T_1 manpower is a crucial step in the process of implementation. Through the activities of the Science In-Service Project, a research-development activity of the Science Education Center of The University of Texas, research evidence indicates that innovative curricula such as Science - A Process Approach requires more than well prepared teachers manuals and student equipment. Effective translation of these materials into classroom necessitates additional training of the teacher. To this end, an in-service training program has been written by teachers and revised as they have experienced needs in the classroom use of the materials.

This in-service program has been designed to meet these two needs:

1. Inadequate academic background to use the curriculum innovation, hence the need for a program to increase teacher competence in the subject area.
2. Inadequate teacher strategies to foster inquiry and individual responsibility in learning, hence, the need for a program to increase teacher competence in teaching strategies for inquiry.

The key means by which specific needs have been identified has been the use of teachers as a source of information concerning both the problems and their relevant solutions. Following the activities of the 1964-65 school year, the T_1 development program was revised utilizing the suggestions of teachers regarding the activities they found most helpful. These suggestions resulted from asking teachers what they wished could be included in the T_1 development program if they could have the opportunity to roll the calendar year back and start the year over. The teachers identified those specific kinds of experiences which they felt would be most helpful in giving them the orientation or preparation for the use of the curriculum innovation. Their suggestions included "less talk and more action" or demonstrations with children with analysis following these demonstrations to identify why specific teaching strategies were or were not used. After the 1965-66 school year teachers were again given opportunities to suggest additions or subtractions from the T_1 development program. Specific suggestions made included more emphasis on planning activities for teachers and science background sessions which are presented in a manner similar to the way teachers are expected to teach.

The focus of the problem of implementing educational innovation becomes the identification of strategies or organization and guiding of learning experiences for students. Logically, the basic source for learning experiences for the teachers should begin with illustrations of teachers teaching. Continue with classroom practice and culminate with analysis of experience. The reality of the learning encounter thus becomes the primary means by which T_1 manpower can be confronted with the need for new knowledge about teaching and guided in their development of the understanding of the curriculum innovation.

Three assumptions comprise the rationale for this approach to T_1 manpower development. If the activities arising from one of these assumptions are omitted it is suggested that the objective of the teacher education program will be far less than satisfactory.

Quite logically a teacher cannot be interested in change if she has no knowledge of either the change or its potential. Therefore,

> Assumption 1 is that knowledge of the innovation precedes and is essential to its implementation.

However, even if one has this knowledge, no action may result because there is no commitment to change. Many have been the inspirational speeches which one has heard and left saying that it was delightful, but no action resulted. The key factor may be that there was no need for action in that there was no commitment on the part of the teacher to any change in the classroom; thus, Assumption 2 is that commitment to use the innovative curriculum is essential to its implementation.

Even with knowledge of change and a commitment to its implementation results may be far from satisfactory for both the teacher and the student. What the printed page communicates varies in direct proportion to the relevant experience of the reader. Therefore,

Assumption 3 is that guidance in the use of the innovation is essential to its implementation.

To be communicated adequately such experiences must draw upon the reality of the classroom in order to provide the basis for real change.

This approach to T_1 manpower development has for its primary focus the educational encounter. To adequately communicate out of the specific science encounter or the rationale for its organization requires many experiences in the reality of many situations. From these experiences and their analysis and because of the knowledge gained, the commitment to, and guidance with the structure of the curriculum innovation, the educational encounter becomes a richer and more meaningful experience for both the student and the teacher.

The specific objectives of the T_1 development program are:

At the completion of the teacher education program the teacher should be able to:

1) Identify and demonstrate the use of teaching strategies which are compatible with the philosophy of Science - A Process Approach. This should include such strategies as:

   A. Describing situations in which students can raise questions, describe procedures and demonstrate appropriateness of conclusions.

   B. Describing classroom situations which illustrate willingness to wait for appropriate responses rather than to tell the "correct" answer.

   C. Identifying learning situations which involve active participation rather than passive listening.

   D. Describing questions which are posed to secure thinking rather than those with the single "correct" pat answer from the student.

   E. Describing learning experiences in which students have the satisfaction of completing a worthwhile task.

   F. Distinguishing between classroom experiences that are directed toward experience objectives and those that are "side excursions" into other areas.

   G. Describing student achievement in terms of observed behavior rather than an opinion of what behavior ought to be present. And

   H. Identifying goal achievements through assessment of student behavior.

2) Demonstration of the acquisition of specific behaviors and knowledges which are part of the structure of Science - A Process Approach including the following:

   A. Distinguishing similarities and differences in objects and events.

   B. Distinguishing between observations and inferences.

C. Identifying the unit or units of measurement appropriate to a particular task.

D. Stating observations in terms of precise position or motion description.

E. Identifying shared properties of objects or events using these in the constructing classification systems.

F. Constructing statements of expected observations based on past observation.

G. Stating observations in quantitative terms when appropriate.

H. Constructing a scheme for recording data so that interpretation of that data may be distinguished from the data.

If the teacher's past experience has not prepared her for the successful use of the new curriculum, she must have additional training. Providing this training requires the development of T_2's at the local level and T_3's for the region. Initially the T_3's have served as a source of information for local school districts, plus conducting their pilot programs. During the first year, potential T_2's have been identified and prepared to serve as local in-service instructors under the coordination of T_3's. The T_3 has thus been freed to initiate pilot studies with other school districts.

As part of the National Science Foundation funded activity, the Science In-Service Project has initiated a T_2 and T_3 development program with these objectives.

At the end of the training period the T_2 and T_3 participants should be able to:

1. Describe the curriculum, Science - A Process Approach, its rationale and psychological basis.
2. Construct science experiences for students which illustrate the program's rationale.
3. Apply the structure of Science - A Process Approach to directing learning experiences with students.
4. Describe a Teacher Education Program for Science - A Process Approach.
5. Demonstrate the Teacher Education Program with classroom teachers.
6. Identify classroom events which are not in resonance with the fidelity of Science - A Process Approach.
7. Construct alternative solutions to the problem of implementation of programs back home. (For example: identify sources of resistance to change and plan appropriate strategies. Demonstrate initiating, intervention and receptivity skills. For example, skills in giving and receiving feedback.)

TO SUMMARIZE:

1. Change in student's experiences require
    a. curriculum materials
    b. a director for those experiences - a teacher - or T_1

2. Change in T_1's require
    a. a T_1 development program
    b. local administrative support
    c. a director or guide for T_1 experiences - local or regional resource staff (T_2's or T_3's)
3. Development of T_2 and T_3 manpower requires
    a. a T_2 or T_3 development program.
    b. local and regional administrative support
    c. a means whereby T_3 staff development can be accomplished.

The development program for T_3 in the region and T_2 local staff was designed as follows:

A. Planning Session (July, 1968) - Four days.

Four members of this session will be the T_3's that have been part of the intern experience of the Science In-Service Project during the 1967-68 school year. They will develop a plan whereby:

1. The needs of the participants will be identified.
2. The means by which these needs can be met.
3. The degree to which these needs met can be assessed.

Each of the four will have the various T_1 development program and T_2 - T_3 development program guides available, but will have the flexibility of developing their individual plan as they may desire. Following the planning session, these four members will serve as instructors for the Leadership Conference.

B. Leadership Conference (July, 1968) - Ten days.

The participants of the Leadership Conference will become familiar with Science - A Process Approach through working with children in the morning. Practice and feedback scales will be utilized to assist the participants in sharpening their perception of the role of the student and the teacher in the program.

Afternoon sessions will be structured around the Teacher Education Program of Science - A Process Approach. Sensitivity training will be utilized here to assist the participants in identifying and handling less than enthusiastic responses of teachers. As part of these activities, role playing will be used as ways of employing skills to assist teachers in change.

Evening sessions will be devoted to those topics of common concern, e.g. psychological basis of the program, analysis of implementation models, anticipation of back-home problems, etc.

C. Practicum (July, 1968) - Ten days.

During the morning the participants will instruct teachers and administrators in the Teacher Education Program as they are introduced to Science - A Process Approach. They will provide opportunity for the participants to practice using the Teacher Education Program or their modifications of it.

Afternoon sessions will be directed toward the preparation of new or modified sessions of the Teacher Education Program and to sharpening skills in feedback. The role playing alternatives to problems that participants identify during the practicum will be considered.

Following the July conference, a monthly conference, either in the Curriculum Demonstration Center or in the field will be organized in order to:

1. Provide exchange of experience.
2. Provide data on the present status of various curriculum innovations.
3. Provide input for the revision of the Leadership Development program.

C. WHO IS BEING HELPED?

Help is being given to school districts and manpower development for both T_1 and T_2 levels. Assistance is being given to regional educational service centers in the development of T_3 staff. The following chart summarizes the activities in the manpower development since 1963, the origin of the Science In-Service Project.

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Austin Independent School District						
T_1	10	88	124	208	442	642
T_2		1	1	3	7	13
T_3 Region 13 Service Center					3	4
San Antonio Independent School District						
T_1		10	19	30	42	62
T_2		-	-	-	-	2
St. Luke's Episcopal School (San Antonio)						
T_1		17	17	17	17	17
T_2		1	1	1	1	1
Northside-San Antonio						
T_1			8	48	143	263
T_2			1	1	1	4
T_3 Regional Service Center					1	1

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Midland Independent School District						
T_1			51	270	406	406
T_2				20	20	22
T_3 Regional Service Center					1	1
Abilene Independent School District						
T_1			30	96	207	207
T_2			2	4	24	24
T_3 Regional Service Center					1	1
Corpus Christi Independent School District						
T_1			30	270	300	300
T_2			1	3	3	2
Eanes Independent School District						
T_1			17	18	18	24
T_2			1	1	1	1
Lackland Independent School District						
T_1			27	27	27	27
T_2						-
Kinkaid School - Houston						
T_1				20	20	20
T_2				1	1	1
Richardson Independent School District						
T_1				24	65	65
T_2				4	6	6

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Waco Independent School District						
T_1					24	60
T_2					30	30
T_3					2	2
Lufkin Independent School District						
T_1				3	27	40
T_2				3	5	5
Amarillo Independent School District						
T_1				8	8	8
T_2				-	-	-
Borger Independent School District						
T_1				8	13	72
T_2						5
Brownfield Independent School District						
T_1				8	30	70
T_2						1
Canyon Independent School District						
T_1				8	16	56
Dumas Independent School District						
T_1				8	19	54
Floydada Independent School District						
T_1				8	16	

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Levelland Independent School District						
T_1				8	8	
Plainview Independent School District						
T_1				8	60	
PESO						
T_3					6	
Adrian Independent School District						
T_1					2	
Bovina Independent School District						
T_1					8	
Boy's Ranch Independent School District						
T_1					3	13
Claude Independent School District						
T_1					4	8
Crosbyton Independent School District						
T_1					8	
Dimmitt Independent School District						
T_1					8	58
Follett Independent School District						
T_1					4	12
Groom Independent School District						
T_1					4	18

	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Hereford Independent School District						
T_1					8	45
Jayton Independent School District						
T_1					4	
Lorenzo Independent School District						
T_1					8	
Olton Independent School District						
T_1					8	
Pampa Independent School District						
T_1					4	16
Sam Norwood Independent School District						
T_1					4	
Vega Independent School District						
T_1					4	
Spearman Independent School District						
T_1					8	24
Sunray Independent School District						
T_1					4	
Snider Independent School District						
T_1					3	97
Roby Independent School District						
T_1					3	

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Colorado City Independent School District						
T_1					6	9
Tye Independent School District						
T_1					8	
Clyde Independent School District						
T_1					16	
Hamlin Independent School District						
T_1					5	
Sweetwater Independent School District						
T_1					5	
Baird Independent School District						
T_1					6	
Stamford Independent School District						
T_1					16	
Marathon Independent School District						
T_1					4	
Ft. Davis Independent School District						
T_1					2	3
Marfa Independent School District						
T_1					12	18
Presidio Independent School District						
T_1					8	18

	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Fort Stockton Independent School District						
T_1					15	26
Sanderson Independent School District						
T_1					3	
Lamesa Area						
T_1					25	
Imperial Independent School District						
T_1					12	20
Stanton Independent School District						
T_1						16
Eastland Independent School District						
T_1						13
Ranger Independent School District						
T_1						7
Putnam Independent School District						
T_1						3
Gorman Independent School District						
T_1						5
Carbon Independent School District						
T_1						3
Austwell-Trivioli Independent School District						
T_1						11
T_2						1

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Karnes City Independent School District						
T_1						12
T_2						2
Refugio Independent School District						
T_1						9
T_2						2
Wharton Independent School District						
T_1						9
T_2						1
Ypleta Independent School District						
T_1						8
Canitello Independent School District						
T_1						9
Forsan Cohoma and Big Spring						42
Pecos Barstow						18
Greenwood-Midland						32
Dallas						
T_1						12
T_2						1
Wylie						
T_1						9
T_2						1

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Forney						
T_1						10
T_2						1
Cedar Hill						
T_1						9
Hockaday Green Hill and Forest Point						
T_1						24
Northeast						
T_1						24
T_2						3
Plano						
T_1						24
T_2						1
Spring Branch						
T_1						48
T_3						2
Olden						
T_1						3
Cisco						
T_1						13
Tulia						
T_1						4
Masterson						
T_1						2
Booker						
T_1						4

	1963 -64	1964 -65	1965 -66	1966 -67	1967 -68	1968 -69
Harlingen						
T_1						40
T_2						2
McAllen						
T_1						12
Rio Grande City						
T_1						6
Roma						
T_1						4
San Isido						
T_1						4
Longview						
T_1						14
T_2						3
Gladewater						
T_1						12
Mt. Pleasant						
T_1						12
Texarkana						
T_1						12
Paris						
T_1						22

RECAP

	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
T_1	10	115	323	1095	2154	3299
T_2		2	7	41	98	135
T_3					9	11

SUMMARY:

A Program for T_1 manpower development has been prepared and revised. Currently it is in use in the State of Texas with nearly 3,445 teachers.

A Program for the development of local resources (T_2 manpower development) was piloted in 1967 and it has been revised for use again in the summer of 1968.

A Program to develop regional resource staff (T_3 manpower development) was also used for the first time in the summer of 1967 and revised and used in the summer of 1968.

It is relevant to note that these Manpower Development Programs have been generated to implement one curriculum innovation - an elementary school science program. Similar procedures are now being planned in elementary mathematics and could be generated for other types of student activities.

REACTION SUMMARY

John Nickel
Wichita State University

What sorts of assumptions do innovators appear to hold underlying the strategies which they employ?*

1. What revisions are typically made in incorporated innovations and what seems to cause these characteristic changes?
2. Under what circumstances is an innovation likely to be rejected by members of the target system?
3. What are the criteria of "success" commonly applied to an innovation by target system members? by innovators? And by dispassionate observers? (if they exist)?
4. If these criteria are carefully applied, what proportion of the adopted innovations is later judged, after all, to be undesirable?
5. Under what circumstances does a system begin to innovate at a different rate than previously?
6. Can there be said to be "learning" of a generalized stance toward innovation such that the system is more open, experimental, desirous of changing, more able to tolerate the ambiguity of the new or perhaps more slavishly addicted to faddism and novelty?

*Major source for the above questions: Matthew B. Miles, Innovation in Education. Teachers College Press, Columbia, 1964.

NEW SCIENCE TEACHER EDUCATION FOR _NEW SCIENCE_*

by

Paul Westmeyer
Florida State University

The Department of Science Education at FSU probably has some of the best science teacher preparation programs in the country. Each graduate is a specialist in one science field, except for those in junior high school or elementary school teacher preparation programs. He has the equivalent of a BS in that subject, plus a full quarter (15 hours) of science education methods - practicum and a quarter of full-time student teaching.

The cry is, not for more science or for more science education in these programs, but for more students. This Department - and certainly most others too - is busily preparing as many teachers as it can get _for the science classrooms of ten years ago_ (or, at best, of today).

Science teaching _will_ change - through college science educators or in spite of us - and it will change soon.

New Science is on the scene. Many projects the country over are instructing teachers (in-service), devising apparatus and facilities, and in general _pushing New Science_. (_New Science_ is used here in the same way it was used in mathematics five years ago. _New Math_ was praised or damned but it wasn't ignored. _New Science_ has just about reached a similar desirable state and science educators ought to see that it goes all the way immediately.)

New Science, by the way, is beyond PSSC (it's more like HPP). _New Science_ is beyond CHEM Study and BSCS and ESCP. (The _New Science_ courses are not all written yet but the Intermediate Science Curriculum Study is coming, for example.) It's beyond AAAS too - Child-Structured Learning in Science is under way.

*A talk given at the AETS regional meeting in Emporia, Kansas, February 14, 1969

And, because science as it is known in the classroom is still changing drastically, science teaching *must* change. It *will* change. It *is already* changing.

The trends - very evident, quite pronounced, and gathering momentum - are: (1) toward individualization of instruction, (2) toward a much heavier use of media other than the spoken word, and (3) toward what is popularly called differentiated staffing.

Certainly science educators should not *follow* these trends; we should *make* them - and others. We should not prepare teachers for existing classrooms; we should prepare teachers who can and will *change* classrooms (and procedures, and content). We should *make* the future not trail along behind it.

We must, therefore, predict what science teaching of the future *should* be like, and we must then get about the business of preparing teachers for that new science teaching. In terms of programs, if the trends listed earlier are accurate estimates, this means that we must:

1) deliberately prepare prospective science teachers individually to do different jobs in the total effort of instructing kids in science (some will need to be content specialists, some writers, some experts at communication, some media specialists, some test experts, and perhaps others),

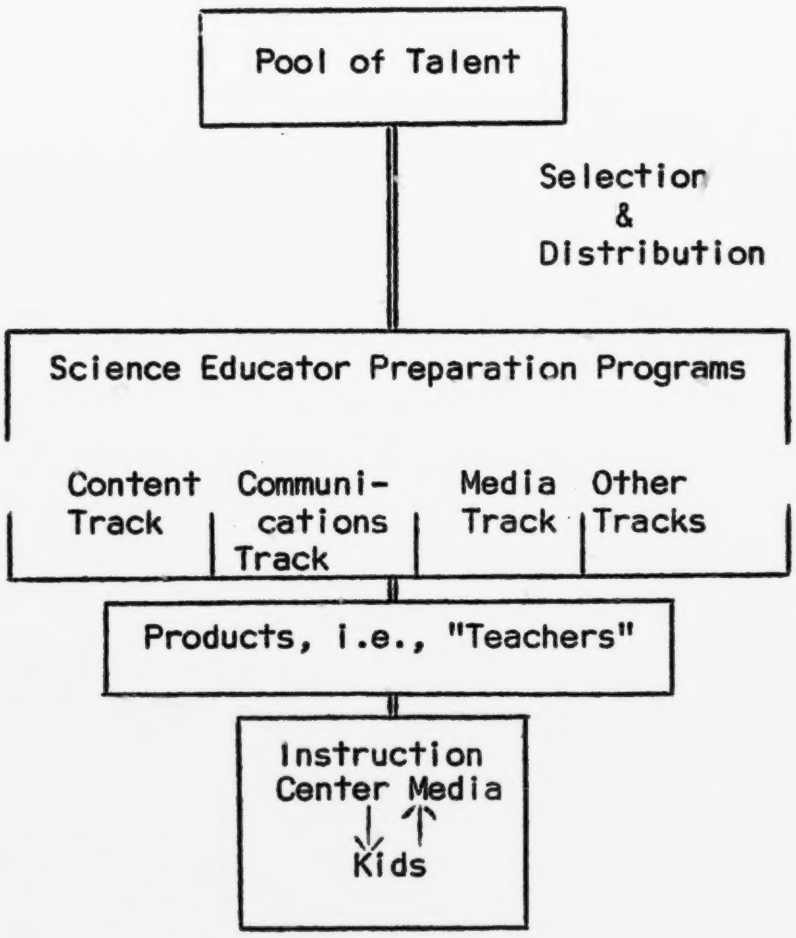
2) change the image of the science teacher and of the job of science teaching (to get *top level* students into our programs, the job must be made *interesting*, *unique*, *prestigious*, and *romantic*),

3) admit that not all science "teachers" need a strong background of science content (*some* do but others need entirely different kinds of background and expertise),

4) establish large numbers of "science for science educators" courses - probably outside of science departments (admitting that college science teaching, for the most part, is bad), and

5) above all embark upon a wide scale coordinated set of research activities in areas related to science teacher preparation.

An outline for this research might be as follows:


Pool of Talent
Selection & Distribution
Science Educator Preparation Programs
Content Track
Communi-cations Track
Media Track
Other Tracks
Products, i.e., "Teachers"
Instruction Center Media
Kids

We must research:

1) effects on learning of various interactions between kids and their instruction center media,

2) ways of getting "Teachers" to behave in those manners found profitable in 1), and

3) ways to select and distribute talent into proper "teacher" preparation channels.

The major kinds of research procedures will probably include:

1) interaction analysis for communications areas,

2) task analysis (hierarchical) for both student behaviors and "teacher" behaviors and for the program of "teacher" preparation in each track,

3) product analysis for the interactions between students and various media, and

4) factor analysis to determine those personality traits, prior experiences, abilities, etc., which are related to success in each of the "teacher" preparation tracks.

Research must be done in a hurry. There isn't time for longitudinal studies. There is also probably little profit in following time-honored procedures - control groups, large samples, .05 significance levels, and others. We must forget such constraints and get on with it.

And when we've done our research, we must believe it. We "know" all kinds of things now about science teaching and science "teacher" preparation which we are doing nothing about. For example:

> Charles Nicholas found that most biology teacher preparation programs include no emphasis on BSCS.
>
> Jacob Blankenship found that BSCS institute graduates have unfavorable attitudes toward BSCS labs in many cases.
>
> Leonard Rochendorfer & Lehman Barnes found distinct relationships between teachers' behaviors and their degrees of acceptance of BSCS objectives and ideas.

Do we run our institutes and regular programs differently than we did before?

> Dudley Herron found CHEM Study students better able to apply their knowledge than "regular" students, and
>
> John Smeltz found that CHEM Study students, in contrast to the usual curve of forgetting, retained 68% of their knowledge over a one-year period. (He also found retention move closely related to achievement, i.e. success, than to ability.)
>
> Many researchers have found no difference on conventional tests between various New Science students and conventional (Old Science) students.

Do the graduates of our "teacher" preparation programs use of CHEM-Study-like approach?

> Many researchers have found no average differences between students taught inductively and those taught deductively.

On the other hand, Warren Riner found that direct involvement of students in the work of their science courses was related to significant achievement in both critical thinking and knowledge of subject matter.

Charles Matthews and Bill LaShier both found that it is fairly easy to change teacher behavior from direct (Flanders Terminology) to move indirect influence.

Surely we should recognize that learners as well as "teachers" use different cognitive and informative styles, forget the all-inductive vs. all-deductive approach arguments, and concentrate on preparing teachers who can and will arrange for direct student involvement in the science learning process.

Gerald Abegg and Glen Crumb reported that a major reason given by students for not taking PSSC physics (and presumably other physics) was that they didn't find it relevant to their goals.

Lee and Cooley reported that science teachers as a group are low in social service interests while other teachers are high in these interests.

Surely these two reports have something to say about our "teacher" preparation programs and about the selection of science teacher prospects.

Gladys Kleinman found that 50% of the questions teachers ask of students are memory questions. (She also found that a greater per centage of critical thinking teacher-questions is related to greater understanding of science - TOUS - by students.)

Silas Schirner (Iowa) reported that teacher responses to student questions, whether positive or negative responses, were nearly always terminal.

Do your graduate teachers still shut kids off?

We have a lot yet to learn in student-media interactions but,

Don Nasca found TV with "voluntary student attention" to be an effective instructional device. (He found lectures via TV to be the least effective of all procedures which he investigated, however.)

In summary: We must do a large amount of research related to the preparation of science "teachers". We must do this research immediately, and having done it, we must pay attention to what we have learned. The results of this research, and this should begin immediately too, should be used in designing science educator preparation programs which will result in our setting the trends in science education of the future. The Association for the Education of Teachers in Science is the professional organization of people who should push these efforts.

INTRODUCING ESCP IN FIVE WESTERN STATES

Dr. Edward Stoever

INTRODUCTION

The Earth Science Curriculum Project (ESCP) is currently just over half-way through the in-service portion of a combined summer and in-service National Science Foundation Cooperative College-School Science Program (CCSSP) through which the ESCP materials are being introduced in at least 79 schools in the fives states of Arizona, Idaho, Nevada, New Mexico, and Utah. The program reflects ESCP's recognition that teacher preparation is the most critical area of concern in effectively implementing curriculum innovation. It is a scaled-down version of a 500-school Cooperative Program which was originally proposed to operate on a nation-wide basis. A major objective of the program is to test the effectiveness of such a program operating on a regional rather than on a local basis. Other objectives are to help fulfill the need for earth science teachers that exist in all parts of the country; to prepare teachers to use an inquiry approach in teaching earth science; to acquaint these teachers with the content and approach of the ESCP course, Investigating the Earth; and to utilize effectively the experience gained by the scientists and teachers who helped develop the ESCP materials.

The program has been a cooperative one in the broadest sense, with three principal groups involved: (1) local school systems, committing themselves to operate a full-year earth science course based on Investigating the Earth; to provide the books and equipment necessary to effectively implement the course; and to cooperate fully in facilities and programming with the teachers whom they nominated for participation; (2) cooperating colleges and universities, including the University of Colorado which acted as host university, who committed themselves to cooperating with the summer and in-service portions of the program, including making credit available; and (3) the Earth Science Curriculum Project, which provided the leadership and coordination for the program and the ESCP-experienced staff. (Appendix I)*

COMPOSITION OF THE CCSSP

The basic format of the program has consisted of two parts: (1) and intensive four-week workshop held at ESCP haedquarters in Boulder, Colorado, and attended by all participating teachers, by the state and local science supervisors, and by the college consultants responsible for the in-service institute protion of the program; and (2) an in-service institute conducted during the academic year by the college consultants in each of the five states. Several goals were achieved by the Boulder workshop. Participants, supervisors, and college consultants were given an intensive exposure to the materials and to the philosophy of Investigating the Earth. Content and process were equally emphasized in order to give participating teachers, most of whom had weak or non-existent backgrounds in earth science, a head start on teaching the year long course. In addition the workshop served to permit all involved to get to know each other better and to develop an esprit de corps which has provided invaluable support during the school year.

*Appendices available from Dr. Stoever.

The summer program featured large group lecture-demonstration sessions conducted by subject matter specialists; small group sessions of 20 to 25 participants working in the laboratory under the direction of an experienced ESCP teacher; weekend field trips; and time for independent study and informal seminars. Time was set aside for teachers, college consultants and supervisors from each local system or group of systems to meet for the purposes of developing tentative plans for the follow-up program during the academic year. Instructional staff for the workshop were involved on essentially a full-time basis, and included six "permanent" ESCP staff members, five content specialists representing the principal disciplines involved in Investigating the Earth, and three experienced ESCP teachers. (Appendix II) All of the preceeding save one were members of the writing teams which developed Investigating the Earth, and most have served in many additional capacities with ESCP. In addition, individual lectures were presented by nine other experts, all of whom have had some connection with the development of the materials.

The schedule of the workshop was quite intense, primarily because it had originally been designed as a six week session, but had to be reduced to four because of budget limitations. Participants were conducted through all twenty-six chapters of Investigating the Earth through lecture-demonstration-discussion sessions emphasizing content, and through participation in all of the laboratory investigations which are integrated into the text. In addition, there were two all-day field trips, evening film sessions, testing, and sessions devoted to special topics on both content and methods. Weekly evaluation of the summer program permitted continual adjustment of the program to make it more relevant to the participants, who actually had access to their program curriculum.

The in-service portion of the program, although coordinated by ESCP, permits flexibility and tailoring to the specific needs of each school system or group of systems. The college consultants, together with participants from each of their districts, formulated tentative plans for the in-service portion of the program while attending the summer workshop. In general, all six of these separate in-service groups have been meeting approximately once every two weeks during the school year, most commonly at a different local school each time. These meetings have featured discussion of problems encountered in teaching; exchange of experience and suggesions; presentation of material from Investigating the Earth by the college consultant or a teacher; content lectures; dissemination of information on evaluation, equipment, and films; movies; and, most importantly, field trips. All consultants have also coordinated at least one of their meetings with other state-wide meetings of various teacher associations. The schedule of these in-service meetings has been coordinated with the teaching schedule of Investigating the Earth.

Coordination of the in-service activities has been provided through planning at the summer workshop, by correspondence with the ESCP staff in Boulder, a CCSSP information bulletin, and through a conference of in-service college consultants and ESCP staff held during January in Salt Lake City, Utah. An overall evaluation of the Cooperative Program will be undertaken in May. Throughout the school year college consultants visited each school involved in the Program at least once.

Eighty (80) participants representing six "centers" were selected for the Program from nominations submitted by school systems and by individual schools. The science supervisors representing each of the six centers were involved in both the recruitment and selection of participants. In the selection, the main criteria was the desire on the part of the schools to implement a program, in this case ESCP. The next criteria was the willingness of the schools to provide texts, laboratory materials, and cooperation; and the selection of as diverse a participant group as feasible within the limitations of distances involved in travel to the in-service meeting locations. No attempt was made to screen nominations on the basis of teacher's backgrounds, and therefore the group as a whole can be considered to be representative in age, background, experience, and school district, of any relatively large population of teachers involved in introducing new materials into a school at the present time. Appendix III summarized various applicant characteristics. Particularly noteworthy is the fact that only two of the groups of teachers majored in an area which could be considered earth science. Appendix IV shows the number of semester hours credit in the various sciences and mathematics possessed by the participant group.

EFFECT OF THE CCSSP

The in-service portion of the Program is still in progress, and all of the data and progress reports which have been accumulating since the initial concept was formulated have not yet been compiled and correlated, so the comments here are scattered preliminary observations. Evaluation of feedback from all parties concerned has been a coninuing part of the program since its inception, and one of the notable features of the operation has been the continuing change and readjustment of both initial and in-progress programming which has resulted from frequent evaluation debriefings by the staff.

The Program appears to have been exceptionally successful in attaining its main objectives of effectively introducing Investigating the Earth into school systems. The response of students, teachers, school supervisors, college consultants, and others involved has been overwhelmingly favorable, and it appears quite certain that permanent changes in educational practice have occurred. Some particularly notable evidences of this are as follows:

A. For the first time, in many instances, teachers have been in contact with higher supervisory personnel, and effectively involved in curriculum planning. All centers report that teachers within their regions have been instrumental in selling school systems and administrators on the expansion of the ESCP course into both additional schools and additional numbers of sections in each school. Some examples of this activity are:

1. One teacher in Salt Lake City is teaching Investigating the Earth to a class composed of hard-core juvenile delinquents. These students have really been turned on by the program, and as a result of a report on this which the teacher was requested to make to the school board, that school system will adopt the ESCP program providing they can find teachers qualified to teach it, and have committed themselves to providing the books and equipment.

2. School administrators have become actively involved in curriculum innovation. First, ESCP, as part of the operation of the coop, required an informal contract signed by the school superintendent in order for schools to participate. Secondly, students were in a position to go to the principal and ask why certain things had or had not happened.

B. A most favorable climate for curriculum innovation has been generated, and a great deal of momentum built up which should extend the effect of the Coop far beyond the present year.

1. There has been reported (by one state science supervisor, as a result of visits to every teacher in his state who is in the Coop), a noticeable increase in the enthusiasm for teaching on the part of the teachers. For the first time, they appear to be really enjoying their occupation! Representatives from the other four states concur that this is a fairly general reaction.

2. Attendance of participating teachers at the in-service meetings has been uniformily excellent, with the only absences being due to illness, with very few exceptions.

3. Many of the college consultants have reported that their professional collegues have become very excited about what is going on, and are assisting in a variety of ways. In two of the centers, the colleges have contributed transportation for field trips at no cost.

4. As a result of the Coop, an EPDA proposal which seems certain of funding has been generated in the state of Idaho, and the science supervisor for that state expects that within a year Investigating the Earth will be offered in nearly every junior high school in the state.

5. All state supervisors have reported that they have received many requests into further expansion of Investigating the Earth into other school districts.

6. Due to the interest generated by the Cooperative Program, all college consultants have received many additional requests from teachers to be admitted into the program, and at four of the six centers, a total of 15 additional people have been admitted into the in-service portion of the program for credit, although not admitted into the Coop itself due to lack of any formal agreement with their school systems.

OPERATION OF THE CCSSP

Cooperative College-School Science Programs are extremely effective means of introducing innovation into schools. Their particular strength lies in the fact that they guarantee that something will happen, because written agreements are entered into between teachers, colleges, and schools. However, there are a number of additional elements which contribute toward a successful operation. Among these are the following:

1. A particularly important element has been the willingness to be flexible and the continuing evaluation of what happened to date, and willingness to alter plans to meet recognized needs at any stage in this history of the program.

2. Prior to selection of participating schools and teachers, a two-day conference was held in Boulder for approximately 50 regional and local science supervisors from the five-state area. This conference served to acquaint supervisors with what the Cooperative Program was all about, and what schools participating would be required specifically to do. The conference also served to encourage school systems to participate in the program, and the biggest selling point here was the fact that the program would provide teacher training.

3. Particular efforts were made to make sure that the people involved knew exactly what they were getting into. The college consultants were encouraged to understand that their role was that of "innovator" and that they needed to actively work with the schools and not relinquish this role to the schools and teachers. Every attempt was made to make certain that school superintendents understood exactly what they were required to do in agreeing to participate in the program. And finally, teachers were made well aware in advance as to what they were getting into. The general philosophy was, "no surprises," and with this understanding, procedural problems have been kept to a minimum.

4. The summer workshop was designed to teach the teachers in the way in which they were being encouraged to teach. The staff made every effort to utilize the inquiry approach in their conduct of the particular sessions which they were responsible for. The daily schedule was scrambled, so that the teachers were aware that they would not be involved in any one kind of activity for too long a period of time. Flexibility of daily scheduling was particularly important. Not only was each weeks work evaluated intensively before making a commitment as to the next weeks schedule, but participants were allowed access to the planning of the program, and many activities were included which were suggested by them. Some of the participants even presented some material. Obviously, attempting to change a teacher's approach to teaching through traditional teaching techniques would greatly reduce the possibilities of success.

5. Fostering communication among participants was particularly stressed. A booklet containing the pictures and names and addresses of all staff and participants in the institute was prepared in advance, and proved very useful in acquainting people with one another. Arrangements were made for all of the participants to live in the same dormitory complex, and this is an invaluable aid to the effectiveness of any institute-type of program. For a workshop of this length, the presence of families was generally detrimental to a participants' obtaining of the maximum benefit from the workshop. In a longer workshop, however, the likelihood of "homesickness" would probably offset this factor.

6. A general participant reaction to the workshop was that the schedule was far too crowded, with the most frequent criticisms being of post-lab discussions which were too hurried, with insufficient

time to study outside of class. (Appendix V) However, participants have been unanimous in recommending that nothing be left out of the workshop. The conclusion is that a six-week or even an eight-week institute would probably be far more desirable. Participants have been unanimous in agreeing that it is highly desirable to work through the entire course which they are going to teach, leaving nothing out.

7. Certain things were insufficiently stressed, according to participant feedback. During the workshop, a great deal of emphasis was placed on instructing the teachers not to read the laboratory portions of the teacher's guide in advance of doing the lab. Unfortunately, equal attention was not given to stressing that the teacher's guide should be read, with the result that many teachers did not read it at all. Back in their own teaching situations, teachers have felt that much more attention should have been paid to proper utilization of the teacher's guide.

Another lack in the summer workshop was that the subject of how to treat and utilize the textural material other than the laboratory investigations was almost totally ignored. A strong need was also felt for much more emphasis on evaluation of students. Also, while the teachers enjoyed and got a great deal of benefit from the field trips which were held, it would have been better to include "backyard" field trips as well, in order to better acquaint the teachers with things that they might do in their own school.

8. Some of the things which it is felt would contribute to the success of future programs include: inclusion of sensitivity training in the summer program; inclusion of micro-teaching experiences; and perhaps provision for allowing the teachers to individualize the materials for use in their own school systems. They would appear to exist the wide need for this latter type of program.

9. All of the in-service programs have, as a result of teacher's response, emphasized field trips considerably. Some of these programs have required teachers or groups of teachers to design field trips for use in their local areas, and it is planned to publish a booklet of these field trips as a state-wide guide to field tripping. Those in-service programs which did not do this the first semester are now planning to do it the second, and this would appear to be a very worthwhile fringe benefit of the Cooperative Program.

In summary, the Cooperative College-School type of program would seem to be an extremely effective way of initiating and implementing curriculum innovation in an area. Further, we feel that our experience has demonstrated conclusively that it is possible to operate such a program on a regional rather than on a local basis, with the advantage that curriculum innovation will procede more rapidly as a whole, and the added benefit of contributing to the development of wider communication among different portions of the country. An encouraging result of the operation of this particular program has been that introduction of new materials in each of the five states involved has stimulated additional activities which appear certain of continuing almost indefinitely.

ECS/sn
2/10/69

IPS LEADERSHIP TRAINING PROGRAM

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IPS Group
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Widespread acceptance of the Introductory Physical Science Program has resulted in a severe shortage of qualified teachers to implement the Program. Summer and in-service institutes, sponsored by the National Science Foundation, have contributed significantly to the pool of trained IPS teachers, but the supply falls far short of the demand. In addition, several areas of the country which have not made much effort in IPS teacher training are making large-scale adoptions of IPS. When school administrators in these areas sought to solve their IPS teacher-training problem with local or regional workshops, they found that IPS workshop teachers were extremely scarce or nonexistent.

In an effort to increase the quantity and quality of IPS teachers, the IPS group obtained a grant from the National Science Foundation to support a leadership program. This program is designed to locate qualified science teachers and to prepare them to instruct other teachers in the use of IPS.

Late in the spring of 1968, information notices on the leadership program were distributed to school districts which had reported a need for trained IPS teachers. In addition, the publishers of the IPS textbook distributed notices and application forms to teachers in schools making IPS adoption for the 1968-69 school year. Potential participants in the program submitted applications in which they indicated their teaching experience, commitments to teach IPS in the ensuing school year, plans for a local IPS workshop for other teachers, and ability to participate in the total program. In each case, the participant's school district was requested to present a letter indicating a willingness to support the individual in the organization of the local workshop.

After 114 applications had been reviewed, eighty-seven teachers were selected to participate in a summer Leadership Conference held at the Colorado School of Mines in Golden. The participants received no stipend for the 2 ½ week conference, but were provided round trip transportation from their respective home towns, room and board, and miscellaneous expenses. Seventy-eight teachers accepted the invitation to participate in the conference and arrived in Golden on June 16 to begin the intensive training program.

The Leadership Conference was designed to prepare the participant to teach IPS in his own classroom and to conduct a local workshop for his peers who are also teaching IPS. Since nineteen of the conference participants had some experience in the teaching of IPS, they were assigned to a special work group with the task of studying some of the

IPS experiments in depth, as well as providing a source of personal experiences which were shared with the remaining participants. The latter were divided into four small discussion groups to facilitate concentrated study of the full IPS program. The staff at the conference rotated among the five groups in an effort to keep the various working sessions fresh and to permit the maximum interchange of ideas between staff and participants. Film showings, testing, and major presentations were held in a lecture hall, with all other work divided between small classrooms and the laboratories.

During the late afternoon and evening hours, small group conferences were scheduled to complete the details of the local workshops which the participants were to conduct. The schedule for these local workshops was set at five full days' instruction prior to the opening of school, and ten full days during this academic year. In a few cases, it was necessary to devise a plan involving 15 or 20 partial day sessions, but in all cases the local workshop was designed to meet for a minimum of 100 hours of instruction.

Personnel from the IPS staff are scheduled to visit each of the local workshops during the in-service phase to aid in resolving implementation problems and to evaluate the overall effectiveness of the workshop program. At the conclusion of the local workshop, each participant who is concurrently teaching IPS will be issued a certificate indicating his or her participation and successful completion of the program. In the large majority of school districts, this certificate will be recognized as professional credit earned by the teacher.

The Leadership Conference Grant will pay one-half of the workshop instructor's salary, with the district or districts sharing the costs of the additional salary and expendable supplies used in the workshop.

Approximately 50 workshops met for the five-day pre-school session in August and are now involved in the in-service phase. As a result of severe financial problems and local organizational difficulties, it was necessary to delay the remaining workshops until the summer of 1969. These workshops will thus coincide with the full-scale implementation of IPS in the schools of the regions they serve.

In October and November, each of the Leadership Conference participants attended one of seven regional three-day meetings. These follow-up sessions provided an opportunity for each of the participants to discuss his or her local workshop with the IPS staff and other Conference participants. Many problems were identified and solved in these discussions.

The feedback from these meetings indicated that the summer training session was quite effective in preparing the participants for their respective workshop assignments. Naturally, some leaders are more sucdessful than others in relating to their peers and in taking charge of the situation.

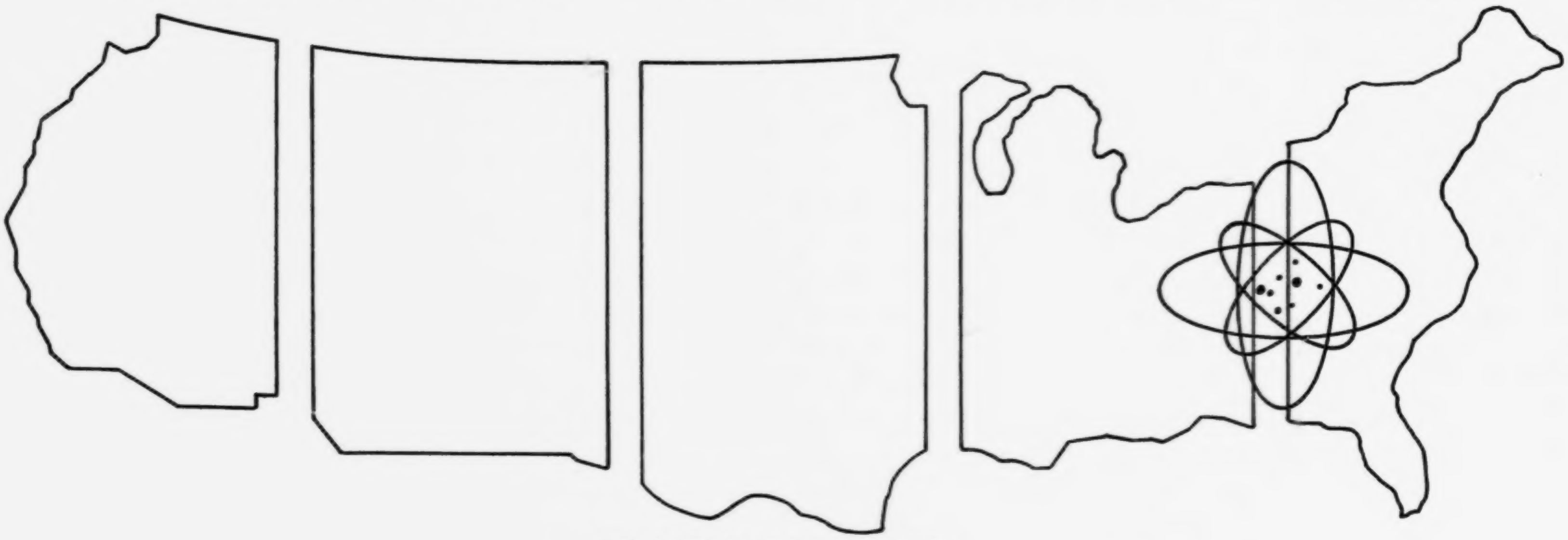
In the final analysis, the most critical problem has been created by local school officials who are reluctant to support the workshop effort. Some school officials have attempted to reduce the workshop to a series of informal chats, while others have insisted that the workshop instructor could not be paid from local funds. In addition, more than half of the workshops are conducted on the teachers' time on Saturdays and evenings.

In situations where the district awards salary credit for the successful completion of the workshop, the teachers are pleased with the arrangements; however, teachers are quite unhappy in the few situations in which neither credit nor released time for workshop attendance is provided. The problems created by these undesirable situations have resulted in a very poor attitude in all involved. The workshop leaders indicate that the five-day preschool meeting is the most valuable part of the workshop plan. They agree that this is largely due to the feeling of fellowship developed in the day-long sessions as well as the anticipation of school opening. The in-service phase of the workshops is constantly plagued with interfering and conflicting activities; the workshops that suffer from lack of administrative support seem to be most affected by these scheduling and attendance problems.

Although the number of teachers involved is not as large as anticipated, more than 350 teachers from 21 states are participating in the local workshops. In addition, many school districts who for any of several reasons were not able to organize a workshop this year, have already scheduled a 15-day session for next year.

While the problems of communication and coordination seem insurmountable, the interest and cooperation generated among the teachers and administrators at the local level appear to be one of the strengths of the program. In a large number of situations, the IPS local workshop is the first attempt at training teachers through their peers and within their own environment. Several colleges have made arrangements to provide facilities and credit for the local IPS workshops. The willingness and ability of the local schools to adopt the IPS Leadership Training Program to their respective situations is the key to the success of the entire program.

The Science Curriculum Viewed Nationally



CLAUDE GATEWOOD

Educational Research Council of America
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A GREATER percentage of high school graduates went on to college a hundred years ago than do today simply because high schools existed almost exclusively for college-bound students from wealthy families. In 1880, only 2 percent of the nation's 17-year-olds were high school graduates, but 2.7 percent of the 18- to 21-year-olds were enrolled in college (including graduate programs). [6] Science was generally ignored by schools prior to 1872, when Harvard University announced that physics and other sciences would be accepted for college entrance. Within a few years most other colleges and universities followed this lead, and our institutions of higher education were setting detailed standards for the science courses that were offered in the nation's high schools. Until about 1900 to 1910, this domination of school science by college scientists resulted in what I shall refer to as an "elite" science curriculum in the nation's high schools. Essential to an understanding of events during the past decade or so is an awareness of this nineteenth century concept of an elite high school science curriculum—conceived, structured, and written by eminent practicing scientists in order to prepare students to enter their classes.

Another series of events during the closing decades of the nineteenth century must be considered in the light of its influence on today's schools in general, and on the science curriculum in particular. Until the 1870's, most free public education consisted of the three R's, and only about half the nation's children (ages 5 to 17) were enrolled in public grammar schools to receive this basic education. It was not until 1874 that the Supreme Court of Michigan ruled in the Kalamazoo Case that free, tax-supported high schools could legally be instituted by the citizens. [2] This landmark decision was quickly followed by similar ones in other states, so that within 40 years free public education for all the nation's children, with compulsory attendance into the late teens, had become the standard.

During the 30 to 40 years that the intended function of the nation's high school science curriculum was being transformed from an almost purely elite, college-preparatory one into one that would teach science appropriate to meet the needs of *all* the nation's citizens, two relevant phenomena took place. First, the events during the Golden Decade (from Becquerel's work in 1895 to Einstein's in 1905) began to redirect the energies of the nation's scientists as the era of "modern science" began to unfold. The second was the rise of an educational "establishment" to manage an education schema, K-12, to provide an appropriate education for all the nation's children. The result of these two trends is now legend, but is quite understandable. Scientists lost interest in overseeing high school science, and it quickly became apparent that the heritage of rather rigorous school science curriculum materials they had generated was quite inappropriate as a fare for the entire spectrum of children now enjoying free secondary education. The materials were repeatedly "watered down" by those who authored texts for schools, and textbooks with such titles as *Physics of the Household,* and *Everyday Science with Projects* appeared in the classroom. By the 1920's, most school science bore little resemblance to the nineteenth-century elite curriculum and was dedicated primarily to helping students come to terms with the world in which they lived. School science had largely become another facet of life adjustment education.

During the past 30 years, applications of scientific discoveries came, with increasing enormity, to impinge on our daily lives. However, the typi-

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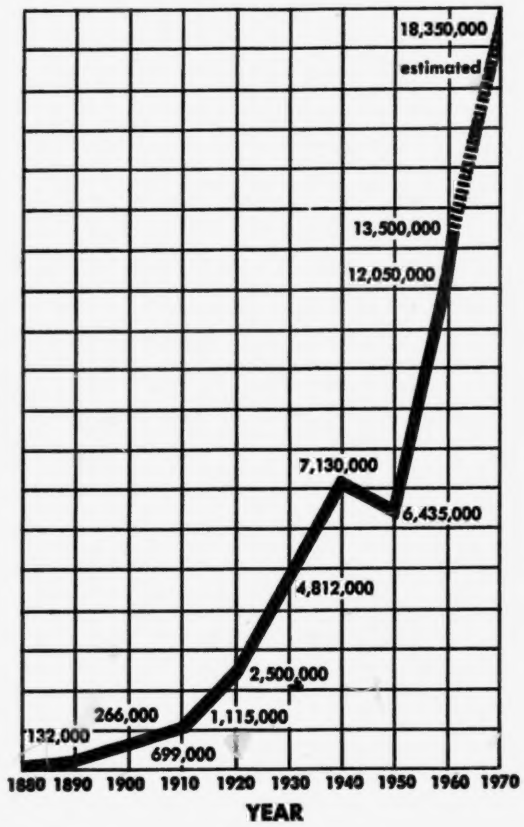
cal high school science course remained an unsophisticated and out-of-date version of what science had been many years before. Although many efforts were made to redirect school science, none was successful until Sputnik, in 1957, jarred the complacency of scientist and citizen alike.

Contrary to popular belief, the launching of Sputnik I in October 1957, did *not* provide the only incentive for current reform in science education. It did, however, give impetus to efforts already underway, and it did dictate the general direction of the revolution by assuring that the federal government would invest heavily in supporting certain of these efforts. And herein lie the causative factors of one of the major points to be made in this paper. The only logical agency of the federal government to be charged with the task of supporting a massive attack on the improvement of school science was the National Science Foundation. The Foundation was staffed largely by research scientists who had come directly from basic research and who understandably leaned toward the support of projects that were dominated by other research scientists. Educators of any kind, including science educators, were generally quite suspect. It would seem to be a kind of natural selection for funded scientists to reject technology and other "applied" aspects of their disciplines when deciding the content of a high school course on that subject. Further, it should be expected that such scientists would quite naturally think in terms of a course that would lay the groundwork for further study in that field.

Thus PSSC, then CBA, BSCS, CHEMS,[1] and many other projects received massive support from NSF for the improvement of specific science courses. Millions of dollars were poured into the support of these efforts, and within five years, about a million children were using either experimental or commercial editions of materials thus produced.

At that point (1962) it would have been difficult to find serious fault with the situation. NSF, pushed by a nearly panic-stricken Congress, had invested millions of dollars in school science improvement—in a pattern that seemed logical at the time. I believe, however, that if one again examines the situation, after an additional five years of observation, a new conclusion is inescapable. In the main, the highly selective infusion by NSF of many millions of dollars into school science improvement, particularly at the secondary-school level, has resulted in the regeneration of a modern, up-to-date version of the elite science curriculum that existed during the latter part of the nineteenth century. Further, much of the excellent scientific material thus created is essentially irrelevant to the needs of a major portion of the students whom, according to both the philosophy and laws of our nation, it should now serve.



Enrollment in public and private high schools. (From DeYoung, Chris A., and Wynn, Richard. American Education, *Fifth Edition. McGraw-Hill Book Company, New York. 1964. p. 172.)*

The PSSC and CBA projects seem to have thus gone further in recreating such an elite course than did those starting a little later. The CHEMS project professed goals that were more realistic, and BSCS intended to create three separate courses in order that something appropriate for all would be included. These four projects were the largest of what might be called a "first round" of science course improvement support by NSF, and in general went further toward recreating an elite curriculum than did later projects.

When it became apparent that the needs of large segments of children were indeed not being met by the initial efforts of the "first round" projects, several kinds of "second round" extensions were made with NSF support. Some examples follow:

1. *A reaffirmation of the philosophy that led to the regeneration of the elite curriculum.* PSSC first initiated its *Advanced Topics* effort for advanced high school courses (beyond PSSC) and for colleges that were using PSSC as a basic text. A year later the same project leaders got support for *Introductory Physical Science* (IPS), which is best suited for preparing bright young people to take PSSC physics. BSCS prepared a set of special materials "for the less able students—who have difficulty with the regular BSCS version." CBA and CHEMS produced supplemental books, guides, and films to aid instruction in their courses. Projects in this category were almost exclusively initiated by the same leadership that directed the first projects.
2. *Projects generated under new leadership.* These are generally intended for students for whom a regenerated elite curriculum was inappropriate. Harvard Project Physics (HPP) is aimed at students who may not go to college and those who will go to college but will concentrate in humanities or social science, as well as students already intent on a career in science. The Engineering Concepts Curriculum Project (ECCP) is aimed at that majority for whom PSSC is either too difficult or irrelevant.
3. *Downward extensions of the science education improvement efforts.* A number of NSF-supported projects have been working on materials for elementary schools. In

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[1] Physical Science Study Committee, Chemical Bond Approach, Biological Sciences Curriculum Study, Chemical Education Material Study.

general they are of two types—those attempting to produce a complete K-6 (or beyond) science program, and those whose efforts are directed toward supplemental materials for several elementary grades. The most complete example of the former approach is *Science—A Process Approach,* produced by the American Association for the Advancement of Science. Some other projects in this category are the MINNEMAST project at the University of Minnesota (plans are for a K-9 coordinated science and mathematics curriculum), and the Science Curriculum Improvement Study (SCIS, a planned K-6 concepts in science; these materials are to include student and teacher materials for K-6, as well as a comprehensive teacher education program). One example of partial coverage for the elementary grades is the Elementary School Science Project, headquartered at the University of Illinois. This project's activity has centered on astronomy, and has produced six books for children in grades 5-8, plus accompanying teacher's guides. The Elementary Science Study started by Educational Services, Inc. (now Educational Development Corporation) is generating independent "units" for use at various levels in the elementary school.

The elementary projects that have been supported by the NSF have, in general, come closer to a sound philosophy with respect to a science program appropriate for all the nation's youth than have those at higher levels. While a college physicist or chemist might easily assume he knew precisely what was needed in a senior high school course, elementary schools presented the scientists with quite a different problem. Here, experience would quickly demonstrate that collaboration of people who were well versed in science and those experienced in elementary school pedagogy was essential. In curriculum development projects, equal status is much more likely to be found between teacher and scientist at the lower grade levels than it is at the higher grades. This growing equality of influence by scientists and teachers at these levels is one of the more promising trends in NSF-supported projects.

THE INTENT of this article is most assuredly *not* to generate another round of accusations and recriminations between the scientific and pedagogical extremities of the academic community, but rather to try to describe the present situation in such a way as to derive the most promising direction for future efforts. To this end, several factors should be considered.

1. The elite curriculum in science of the late nineteenth century may have been both appropriate and effective at the time when we were a developing young nation that was largely agrarian.
2. In a society that is as scientifically and technologically oriented as ours is today, all students should be broadly educated in science, its its processes, its products, its philosophy, and its impact on society. For some, enrichment and advanced study in addition are quite appropriate. The single most important goal of school science must be to prepare scientifically literate citizens for the future; an important but secondary goal is to assure that those talented students who will pursue higher education in science are adequately prepared to do so. Even such enlightened writers as John Goodlad [4] inadvertently tend to belie this, however, by referring to the schools as "pre-collegiate." NSF has no school division, but a Pre-college Education in Science Division.
3. Largely because of the irrelevancy of either an elite or a watered-down curriculum in science in relation to their daily lives, an alarming majority of today's children elect to study only as much science as is required. It is outside the scope of this paper to consider the gravity of the dropout problem. However, it must be noted here that either the content or the manner of presentation in other school disciplines is equally irrelevant in contemporary life. This and other factors result in a fourth of our children failing to complete high school. These school dropouts can still outvote all our college graduates by a factor of more than three to one. [9]
4. Materials produced by NSF-supported projects are by far the most up to date as far as scientific content is concerned. Certainly they should not be totally junked in any effort to produce more relevant materials for the school population that has been largely ignored heretofore. Much of this material is appropriate for certain children.
5. It is equally foolish to expect either the noneducation-oriented research scientist or the nonscientific educator, working in isolation, to produce meaningful science materials for all the children—we have witnessed the limitations of both kinds of efforts during the last 50 years. Representatives of the various disciplines of science, together with science educators and learning theorists from various schools of thought must all be included, and no one of these should be subjugated or dominated by the other. As Hass put it: "We need a philosophical synthesis, appropriate to our world, and to the learners, that can be taught . . . and only the scholar working alongside the educator can achieve this." [5]

FORTUNATELY, there is a new philosophy evolving in science curriculum restructuring—an integrated effort that would cut across traditional course lines. There are now about 25 such projects in the country that are rather loosely joined together in the Federation for the Unification of Science Education (FUSE).[2] Most of these projects involve the efforts of a single school system with little if any outside support. Federal support in this area is still given largely for projects with limited goals, such as the integration of the physical sciences or elementary school science.

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[2] Membership information may be obtained from Jan Housinger, The University of Chicago Laboratory Schools, 1362 East 59th Street, Chicago, Illinois 60637.

NSTA, through its curriculum committee, has taken the position that conceptual schemes or big ideas of science offer the best basis for curriculum building. A set of schemes and explanatory material, as well as the rationale for this position, appears in the Association's publication, *Theory Into Action in Science Curriculum Development*.

The nation's largest effort to produce an integrated science curriculum is being conducted by the science staff of the Educational Research Council (ERC) of America (formerly the ERC of Greater Cleveland).[3] This project is staffed by about a dozen scientists and science educators and a like number of supportive staff. Experimental materials are written cooperatively by the ERC science staff and practicing teachers in the Council's 30 school districts. During trial and revision of the materials there is constant feedback and liaison between ERC science staff and teachers using the experimental materials. Included in the Council's cooperating school districts are public, private, and parochial schools that include slums, wealthy suburbs, and rural environments. The ERC science staff is working on a 10- to 12-year project to produce an interdisciplinary science curriculum, including materials appropriate to meet the needs of *all* children from kindergarten through the twelfth grade. This curriculum will also deal with the interfaces between science, mathematics, social science, technology, and the humanities.

Little is now known about the results of interdisciplinary science instruction, but what is known is encouraging. From 1959 to 1967, an interdisciplinary science course was offered at The Ohio State University school under the direction of Victor Showalter and Irwin Slesnick. From 1963 until the school was closed in the spring of 1967, graduating seniors had had only Science I, II, III, and IV, instead of the traditional general science, biology, chemistry, and physics. USOE-supported research established that the students in this unified high school science sequence attained greater interest in science and greater scientific literacy than did their counterparts in conventional programs. They also elected college science to a significantly higher degree. Further, these gains were not achieved at the expense of less effective preparation for college science. [8] As René Dubos has indicated, science should be "meaningful to the living experience of man." [3] It would seem that an integrated science curriculum could more closely approach this goal than does the series of unconnected courses on selected disciplines that now make up our offerings.

It cannot be denied that the many millions of dollars directed by NSF into the improvement of school science have made a tremendous impact. Surely there are those who would consider the "modern" courses themselves to be the most valuable outcome of this effort. It is the conviction of this writer, however, that the most valuable product of this past decade of revolution in science education is to be found in the minds of the nation's science teachers. They will probably never again be bound to a single concept of science education, either by tradition or mandate.

In a statement that is well worth reading, Archibald MacLeish has spoken eloquently about the need to humanize science—to relieve the omnipresent frustrations of today's citizens by allowing them to participate in the scientist's plans for tomorrow's wonders. [7] George Basalla argues with equal eloquence that the social and epistemological goals of science and its relationship to technology and the economy should be a part of school science. [1] This writer would argue that both Basalla and MacLeish have suggested aspects of science that are necessary but not completely sufficient. Considering the importance of science in our lives, school science should be of the sort that students would elect to take, rather than avoid. It should relate meaningfully to their world and to their aspirations for the future.

Kahlil Gibran once wrote that a truly wise man would say, "I have found *a* truth," not "I have found *the* truth." That an elite curriculum is best for a portion of our children cannot be denied. To insist that such a curriculum become a procrustean standard, with those who fail to meet its demands continuing to fall by the wayside, is patently self-destructive for any society in today's world. Science was not created in separate disciplines, but so divided for the convenience of scientists. The course content improvement projects supported by NSF were a logical first step in the improvement of science education in our schools, but it is now time that we take additional steps in promising new directions. Let us hope that both federal and private sources of funds will in the future be used to accelerate the investigation of new ideas in science education rather than the solidification or excessive proliferation of those whose particular finite worth has already been established.

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[3] Information about this project may be obtained from Dr. Ted F. Andrews, Director of Science, Educational Research Council of America, Rockefeller Building, Cleveland, Ohio 44113.

REQUESTED PAPERS

PROCESS APPROACH IN BIOLOGY INSTRUCTION[1]

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Kansas State Teachers College, Emporia
Donald C. Edinger,
Francis A. Ferko,
Hallard T. Murray, Jr.
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Recently we have been bombarded with slogans about teaching: "Lecturing is dead;" "Individualize instruction;" "De-emphasize rote memorization;" "The student should be self-paced." These are great slogans, but how do you put the words into action? What can you do instead of lecturing? How do you individualize and self-pace instruction? How do you de-emphasize rote memorization and what do you require in its place?

We have developed and used in the college classroom instruction which provides one kind of answer to all of these questions (4). There are no lectures, no formal laboratories, rote memorization is nearly absent, all instruction is individualized, and every student works at his own pace. The purpose of this paper is to briefly describe the way this introductory course in college biology is constructed and, more importantly, to provide quantitative evidence of its success in the classroom. This is probably the first use at the college level of the process approach and evaluation model developed by the American Association for the Advancement of Science (1).

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[1] Paper presented by E. B. Kurtz at the Annual Meeting of the Entomological Society of America, December 4, 1968, Dallas, Texas.

The Process Approach

Suppose you were to design a beginning program for teaching a person to be an airplane pilot. How would you know when your instruction is completed? That's easy: when the student can take off and land the plane. We call this the terminal task. How will you know the student can take off and land a plane? Give him a true-false test? Perhaps you prefer a multiple-choice test? Somehow, such tests don't seem too adequate for assessment of flying ability. Obviously, an essay test is necessary. Just ask the student to write an essay on how to fly an airplane. As accustomed as all of us teachers are to using essay tests, writing about how to fly still doesn't seem to be adequate assessment of a student's ability. I'm sure you agree that the student must demonstrate his newly acquired ability. To wit, he must show that he can fly a plane by making a solo flight. We call this demonstration of ability to do a task a competency measure. The student is either able or not able to do it.

What about the sequence of instruction prior to the terminal task? In other words, what subordinate competencies must a student acquire that will lead up to and help a student to be able to fly a plane all by himself? Some subordinate competencies are more complex than others and will come late in the instruction program; the simplest competencies will come first. When all these competencies are arranged into a learning sequence, a behavioral hierarchy is produced (2).

What about grades for your student pilot? You could do what most teachers do, award an A, B, C, D, or F; but who wants to fly with a pilot who did not get an A? What you need to do is award grades of "pass," or "A," and "fail." The competency measures permit this, as mentioned earlier.

Suppose that you have one hundred students enrolled in your course on flying. How many of these students do you hope will be able to demonstrate the terminal task (solo flying) at the completion of your course? Ideally, you want all one hundred students to be able to fly solo. But most of us aren't that good at teaching, so let's settle for something more realistic, say, 90 percent of the students. This means that if your instruction is successful, ninety students will get a grade of "A" or "pass," and ten will fail.

Now here's an important attribute of this approach to teaching. Whose fault is it if more than ten students fail? Is it the fault of the students who fail or you, the instructor, for not providing adequate instruction? In the design of our general biology course, we have worked on the premise that it is the instructor who carries the burden for providing adequate instruction. This does not mean that students do not have to study and work hard. It does mean that the instructor is obligated to provide interesting, good instruction that has a high probability of getting the student to want to and be able to demonstrate the terminal task.

Objectives and Hierarchy for General Biology - A Process Approach

We began construction of the course by asking ourselves this question: What do we want the student to be able to do at the end of the instruction that he couldn't do at the beginning? In other words, we specified how the course would change the student (3, 5, 6, 7). These objectives constitute minimal changes in the student. Hopefully, the student will change in many other ways -- his attitude toward science, his appreciation of nature, and so forth -- but the objectives we stated specify the least amount of change in the student we would accept. And, having stated these changes, we obligated ourselves to assess the acquisition of each one by each student. Several of the 74 objectives for our course are shown below (4). The terminal tasks are objectives 1 to 5.

1. The student should be able to demonstrate the use of an operational definition during the conduct of an experiment.

2. The student should be able to demonstrate the selection of of a problem for study by stating the problem operationally in the form of an inference, prediction, or description of change of a variable in response to one or more variables.

3. The student should be able to demonstrate the use of a table and/or a graph of data as a means to aid communication in a report of an experiment.

4. The student should be able to construct a report which is neat, grammatically correct 95% of the time, and scientifically acceptable as to content and style.

5. The student should be able to construct and demonstrate a procedure for calibrating an instrument.

20. The student should be able to construct a multistage classification of a set of objects and name the basis of the classification in terms of observable properties of the objects.

48. The student should be able to name the freezing and boiling points of water in degrees Celsius and degrees Fahrenheit.

54. The student should be able to identify and name the amount and direction of change between two temperatures, either positive or negative, in degrees Celsius.

63. The student should be able to apply rules to determine the volume and area of a regular three-dimensional object, given the rules (formulas).

69. The student should be able to name decimal names for fractions and other measurements.

70. The student should be able to describe the taste, sound, hardness, texture, and odor of an object.

71. The student should be able to domonstrate the measurement of length, volume, and mass of an object in metric units, given appropriate measuring devices.

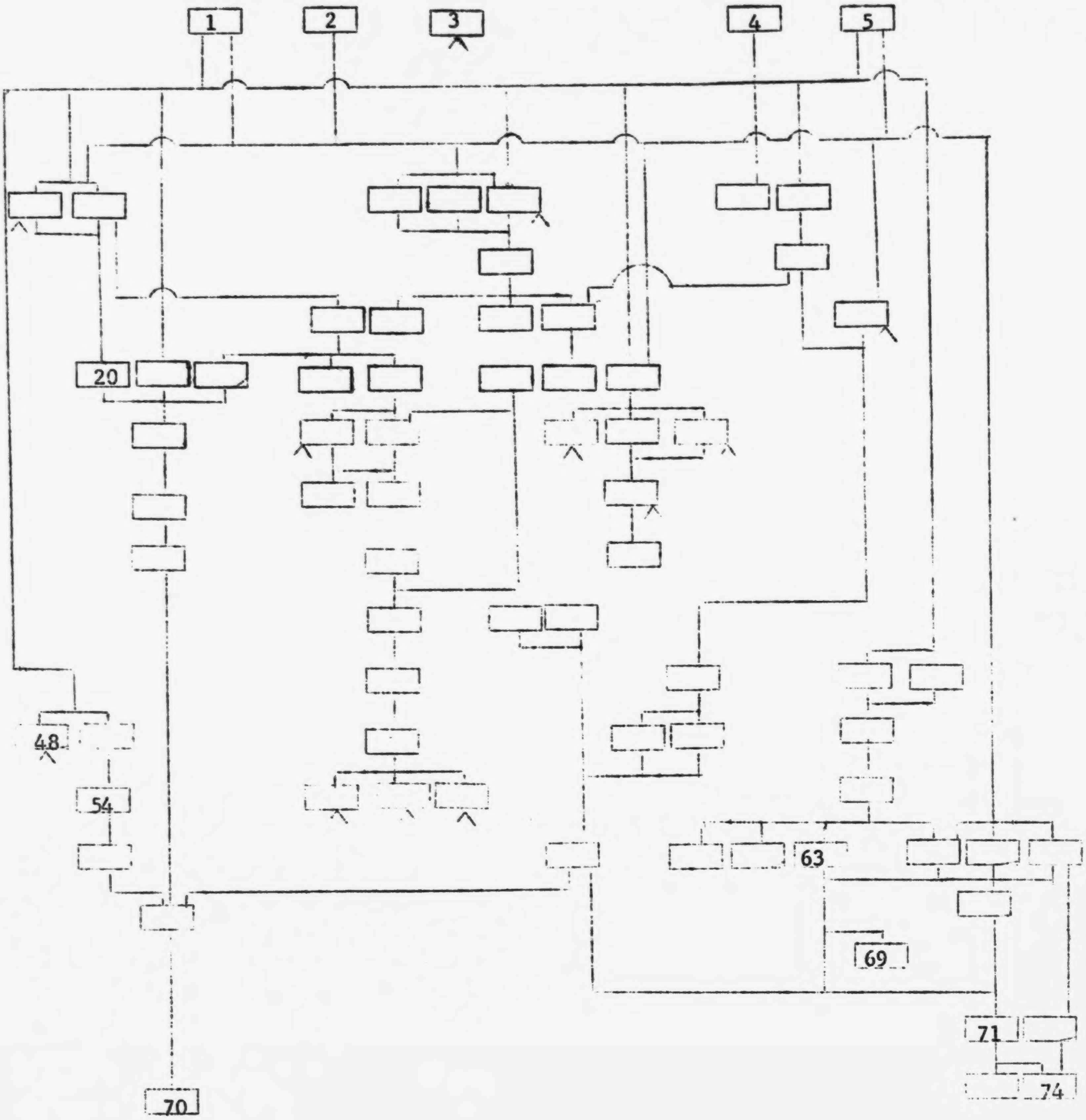
74. The student should be able to identify which of two containers or objects has the greater volume.

Next we agreed on how the competence of each student would be assessed. We decided that each objective would be assessed in a situation different from the context of the instruction. Rote memorization is not enough; we want students to be able to apply their competencies to new situations (1). If students cannot do this, there really is not much purpose in learning it in the first place.

Our third task was to arrange the objectives in a hierarchy (7). Our first hypothesis as to learning dependencies is shown in Figure 1. Each frame of the hierarchy represents one objective. The five terminal tasks appear at the top; the simplest tasks appear at the base. The numbers in certain frames refer to the objectives stated earlier.

Instructional units for the objectives in the hierarchy were written. Each unit consists of the objectives for the unit, self-appraisal items and acceptable responses so the student can assess his own competencies, and instructional activities. Most instructional units require biological materials, laboratory apparatus, and some reading. Some units require the use of outside areas in the front yard of the student's home, dormitory, or around the Biology Building.

After completion of each instructional unit, the student is given a competency measure for each objective in that unit. If he performs


1
2
3
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74

Figure 1. Behavioral hierarchy for General Biology - A Process Approach (4). The terminal tasks are numbers 1 to 5. Each represents one objective.

acceptably, he is given instruction for the next higher objectives in the hierarchy. If he performs unacceptably on the competency measure, he is given additional instruction and help.

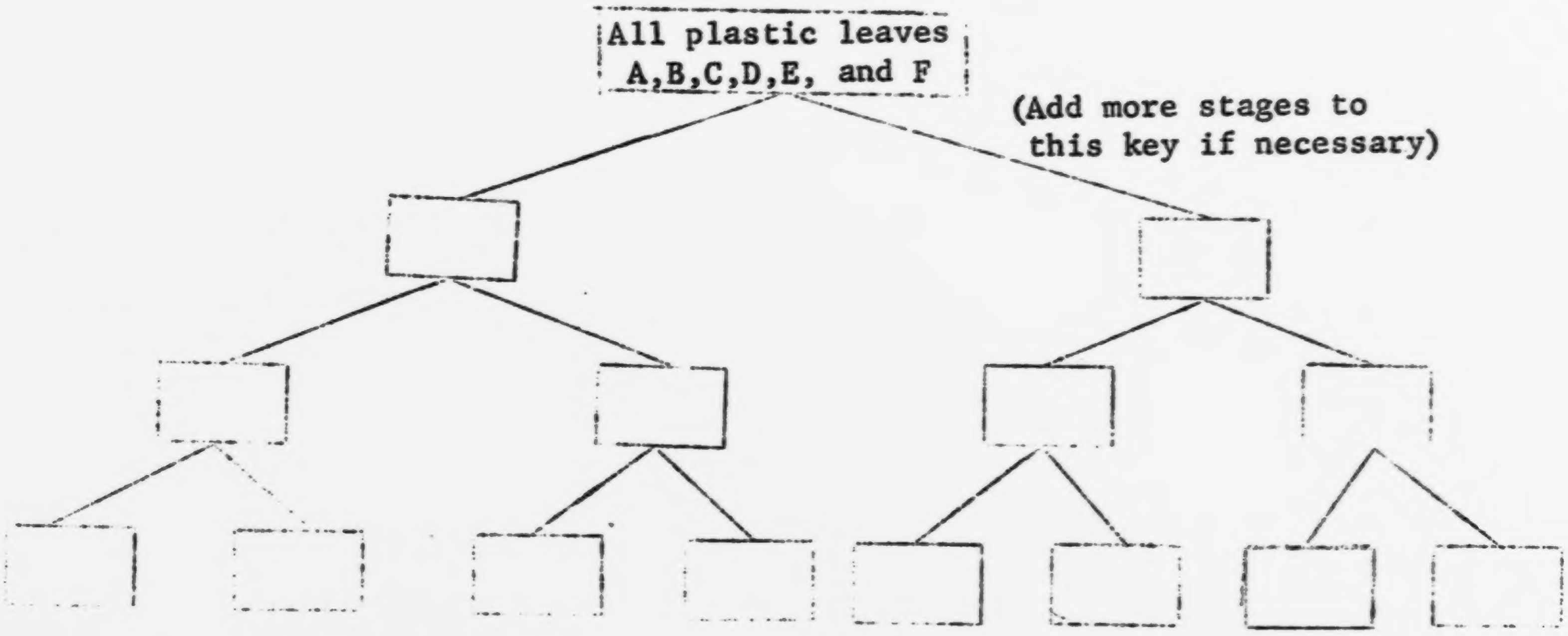
Our final task in designing the first experimental edition of this course was to construct a pre- and post-measure. Because we intended to individualize instruction, we needed to be able to diagnose each student's repertoire of competencies at the start of our course. We did not want to waste a student's time on instruction for a competency he already possesses. Conversely, we did not want to assume a student possesses competencies he does not have. The pre-measure is used to diagnose each student's science competencies (as defined by our objectives for the course) as he begins the course. Instruction is prescribed on the basis of this diagnostic pre-measure. The post-measure is similar to the pre-measure and is used at the end of the course to provide data for validation of the hierarchy. Revisions of the hierarchy shown in Figure 1 have been based on the post-measure. The post-measure can also be used to assess the retention of competencies. Retention studies are being conducted but data are not available.

Experimental Tryout of General Biology - A Process Approach

The first use of this course in a college classroom was during the spring of 1968. Of the 144 students enrolled in the course, 96 were sophomores. For interpretation of data given below, it is important to know that 80 percent of the students enrolled had completed a semester of college chemistry, 78 percent had completed one semester each of college physics and modern mathematics, 49 percent had completed one semester of college geology, and 29 percent had credit in other science and mathematics courses.

Diagnosis of the science competencies of all students was made the first week of classes. Students were told at the time of the pre-measure that it is a diagnostic measure; each task performed acceptably by a student would be eliminated from the course of study for that student; if a student could demonstrate all tasks acceptably on the pre-measure, the course would be half completed for that student. The mean score on 35 tasks from the lower half of the hierarchy was 43 percent. The competency items from the pre-measure which assess the objectives shown earlier are given below. These items, and the objectives which they assess, represent science competencies which we expected most of our students would possess. The mean score for the whole class on each item is shown in parentheses.

Item 35. (Objective 20) Using the set of plastic leaves from Sack L, construct a dichotomous (forked) classification key so that each of the six "leaves" could be identified by another person. Identify each leaf by its letter code. At each stage of the classification name the characteristic you have used to classify the leaves.



(Add more stages to this key if necessary)

(24% acceptable responses)

Item 23. (Objective 48) Fill in the blanks in the following statements:

The freezing point of water in degrees Celsius (Centigrade) is ________°.

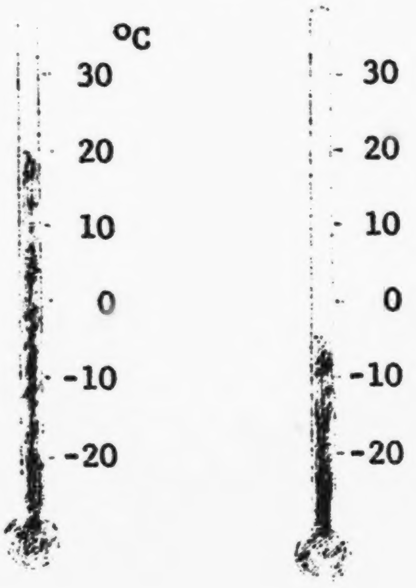
On the Fahrenheit scale the freezing point of water is ________°.

The boiling point of water on each of these temperature scales is ________° Celsius and ________° Fahrenheit.

(26% acceptable responses)

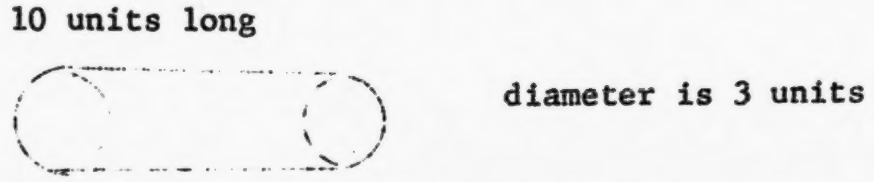
Item 31. (Objective 54) Here are drawings of a thermometer as it appeared on two different days. The minimum temperature on each day is shown. Circle one of the following numerals which best represents the amount and direction of change in temperature from Day 1 to Day 2. If no correct numeral is shown, put an "X" in this box. ☐

15° 10° 25° -10° -15° -25° 0°



(60% acceptable responses)

Item 15. (Objective 63) A Biology 12-er measured a cell and found that its length and diameter were as shown in this diagram:



Using the measurements shown and the appropriate formulas (select from the formulas given at the bottom of this page), calculate the following quantities for this cell. Be sure to specify the unit of measure in your answers.

Area of one circular end of the cell is __________
(Show how you calculated the area here:

Volume of the cell is ____________________________
(Show how you calculated the volume here:

(15% acceptable responses)

item 9. (Objective 69) Write each of these numerals as a decimal:

1/4 is the same as ________________________

1/100 is the same as ________________________

1 4/5 is the same as ________________________

(80% acceptable responses)

Items 1, 2, 3, 4. (Objective 70) Remove the object from Packet A. Describe the taste of this object.

Remove the objects from Packet B. Strike the metal lid with the nail. Describe the sound emitted when you strike the object.

Remove the object from Packet C. Describe the texture and hardness of the object.

Remove the object from Packet D. Describe the odor of the object.

(53% acceptable responses)

Item 11. (Objective 71) Find Packet H and remove the objects from it. You are to make several measurements of the piece of plant stem. In addition to the metric ruler, you may use any of the materials and equipment at the front desk. Please use the materials only at the front desk; do not bring them to your desk.

Length of the piece of stem, in centimeters _____

Diameter of the stem, in millimeters ___________

Volume of the stem, in cubic centimeters (milliliters) _______________

Mass of the stem, in grams ____________

(34% acceptable responses)

Item 5. (Objective 74) Remove the two objects from Packet E. You are to compare the volumes of these two objects. You may use any of the materials and equipment at your table to help you make this comparison. How do the volumes of the two objects compare? _______________________

Describe how you would show another person how you arrived at the above decision. ___________________
____

(57% acceptable responses)

We were shocked by the results. Nevertheless, instruction for a student was prescribed on the basis of his performance on the pre-measure.

Was the Course a Success?

So the course began. We met each student every week at least once, sometimes three or four times. Space does not permit description of the mechanics of the conduct of the course, but suffice to say that the response of the students to individualization, self-pacing, and the personalized treatment was excellent.

Four months after beginning instruction, 55 percent of the students had completed all tasks including the terminal tasks. Several students finished as much as three weeks early. Twenty percent of the students completed all tasks except the terminal tasks; these students were awarded a grade of "B" or were permitted to take an "Incomplete" and continue working toward completion of the course. Twenty percent of the students enrolled completed about 55 tasks and were awarded a grade of "C." Hopefully, future revisions of the course will improve the instruction so that this group will be eliminated. Five percent of the students initially enrolled dropped out or completed fewer than 55 tasks.

The post-measure was administered to all students at the end of the semester. Students were told that the post-measure would have no effect on their grade in the course and they were asked not to study for the post-measure. To our knowledge, all students willingly agreed to this request. The responses on the post-measure show that approximately 80 percent of the students were able to demonstrate acceptably 80 percent of the tasks they had completed during the course. This is a remarkably high level of performance, considering there was no review or studying by the students. Nevertheless, we believe we can do better after further revisions and classroom tryout of General Biology - A Process Approach.

Conclusion

We have described, and given evidence for, one alternative way of designing and conducting college instruction. It requires mcuh effort to learn the technology for doing this, and much effort and time are required to conduct a course in which instruction is prescribed for each student on an individual basis. But the system does work. We want to encourage you to consider the process approach to instruction, too. We feel you will be amply rewarded for your efforts.

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IMPLEMENTING SCIS MATERIALS INTO THE MAGNOLIA, ARKANSAS SCHOOL DISTRICT

The Time was Ripe

The NSF Leadership Conference at the University of Texas* (Summer 1967) provided the speaker with a full and rich experience in both the background and implementation techniques necessary for the proliferation of SCIS and AAAS elementary school science inquiry innovations. The speaker was "loaded" with implementation ideas, role playing, and sensitivity training----loaded for "bear."

With the kind assistance of Dr. David P. Butts and Dr. Mary Budd Rowe, a tentative proposal (NSF Cooperative College-School Science Program) was written with the objective of implementing the SCIS Innovation into the primary grades of the five elementary schools in the Magnolia Public School System.

Upon return to Magnolia, Arkansas, the Curriculum Supervisor, Miss Louise Phillips, was contacted and a meeting of the counselor, the school superintendent, five elementary school principals, and the speaker was scheduled. The speaker went to the meeting with an attaché case of information which he felt was tantamount to selling SCIS to the Magnolia Schools.

The meeting was called to order and the counselor asked, "B. C., what science program are you trying to sell?". The speaker issued a typewritten two page summary describing the philosophy and purposes of SCIS. The group read the two page summary and then the speaker was asked politely to leave. The speaker was invited back after an hour period which actually lost five minutes, given a cup of coffee, and asked one simple question, "Where have you been and why did you not come sooner?" The school system was in the right frame of mind. New innovations had been recently added in math and reading and the counselor was just waiting for someone to assist her in implementing a new science program. The proposal was mailed to NSF.

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*NSF Leadership Conference, Science Education Center, The University of Texas, June 28th to July 28th, 1967 was designed to train college professors in the task of implementing improved science curriculum in elementary schools.

MAGNOLIA TEACHERS-*-PUPILS ATTEND SSC SCIENCE WORKSHOP

Thirty-six Magnolia Elementary School teachers and principals attended a three-week science workshop at Southern State College, July 8-26. Thirty-three children in grades one, two and three attended the workshop one hour daily to learn about science and to help the teachers learn to apply new science methods.

The cooperative workshop was supported by the National Science Foundation and was a joint venture of the Magnolia Public Schools and Southern State College. B. C. Dodson, associate professor of chemistry and science education at Southern State, was the director of the project, and the assistant director was Louise Phillips, curriculum director of the Magnolia Public Schools.

Mrs. Betty Jewell fron the Tulsa Public Schools, and Mrs. Carol Frazier fron the University of Oklahoma Laboratory School served as demonstration teachers. Dr. John W. Renner, who is director of the Science Curriculum Improvement Trial Center at the University of Oklahoma, was the visiting lecturer. Dr. Renner has written numerous articles on elementary science education and has been an active force in creating materials to be used in science.

Dodson, the project director, has been actively engaged in science education and has worked with Dr. Renner closely on the development of programs and materials.

The teachers and pupils received training and experiences with the Science Curriculum Improvement Study (SCIS) materials which will be taught in the primary grades of the Magnolia Elementary Schools and a few upper elementary grade classrooms in the 1968-69 school year.

SCIS is a course content improvement project which has developed a sequential, articulated, elementary school science program. This program is based upon the structure of science as seen by modern scientists, is consistent with a modern view of the nature of intellectual development of children, and reflects the experience of elementary teachers working with preliminary SCIS units. Through the program, it is hoped that students will have a useful and intellectually stimulating introduction to science.

The Magnolia Elementary teachers received experience which will help them use SCIS materials and equipment effectively. The elementary teachers observed two experienced teachers, Mrs. Frazier and Mrs. Jewell, teach the pupils and at the end of each lesson the teachers discussed with these teachers the pros and cons of the lesson.

The course work gave considerable emphasis to laboratory work; this was perhaps the most effective way to develop some understanding of the conceptual structure of science and to gain a "feel" for the kinds of science experiences the students will have. The observations of experienced teachers provided the basis of ideas for the new science innovation as well as a chance for teachers to practice the art of listening to what children have to say.

The teachers and principals became acquainted with the SCIS materials and equipment by criticizing overview films, trying out an experiment and then going over it with two or three fellow teachers acting as students while other teachers observed, trying out an experiment and going over it with several pupils, and discussing lessons with the professors.

The teachers experienced a new technique--low ratio teaching also known as microteaching. The first day of the micro-session each teacher taught a science lesson to one student. Dodson, Frazier, and Jewell acted as observers and consultants. The teachers shared their experiences.

Recorder tapes, on a voluntary basis, were made of the teaching experiences and the teachers were asked to criticize the teaching methods and to have professors offer suggestions. These sessions were used to develop the art of listening to the children, letting them discover for themselves, and to develop the ability to ask good questions.

With the art of listening to children well in hand, the teachers can find the appropriate questions to guide the children to further observations and discoveries without telling them what they are to see and find. The low ratio teaching sessions continued until four teachers and four pupils were involved in a group, three teachers acting as observers.

The pupils also enjoyed listening to the tapes. Teachers enjoyed the experiences of working with and receiving constructive criticism and suggestions from fellow teachers and professors. Part of the workshop was devoted to planning and preparing for the 1968-69 school year. Dodson continued to work with the teachers two days per week for the 1968-69 school year as an advisor, consultant, and teacher.

The teachers were impressed by the interest, success, and activity of the children. The children found that science is a special way of finding out about things they did not previously know.

A primary concern of SCIS is that children's science experiences be consistent with the nature and structure of science. The first grade students are studying units of very basic concepts--material objects and organisms, and second and third grade students are studying the interactions unit.

ACADEMIC YEAR

The speaker has enjoyed working with the teachers as a consultant, classroom teacher, and fellow investigator. In addition to these duties, he has held seminars in each of the individual schools, and has made talks to P. T. A. groups.

The upper grades elementary teachers have consistently posed the question, "When are you going to help us?" The speaker has done some teaching at this level also. A proposal was written to NSF to assist in implementing the discovery method of teaching science into the upper elementary grades. This grant was received January 3, 1969. A workshop initiating July 8 and ending August 1 will give the 30 upper grade (grades 4, 5, and 6) elementary teachers experiences in teaching the discovery method of teaching science. The upper grade students will study relativity systems, sub-systems, and populations.

Plans are being formulated to implement the inquiry method of teaching science into the Junior High grades in the fall of 1970.

Other school systems are asking for workshops and assistance in the new way of teaching science. Counselors have visited the Magnolia classrooms and have enjoyed the educational experience.